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Section of the History of Medicine

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F. J. V. Broussais (1772–1838): His Life and Doctrines

By J. D. Rolleston, M.D.

Of the many illustrious medical men who flourished in the first half of the last century, none obtained greater eminence during his life-time, though his doctrines became obsolete before his death, than François Jean Victor Broussais, the centenary of whose death on November 17, 1838, has recently been celebrated by several interesting articles in the French medical press (Babonneix, Bonnette, Gallois, Genty, Huet, Larcher, and Lemée). He was born on December 17, 1772, the only son of a local doctor, at Pleurtuit, a village near St. Malo, where the centenary was celebrated on September 11 by a distinguished assembly including the great-grandson of Broussais, ex-deputy for Algiers, aged 83 (Bonnette).

He was educated at the neighbouring town of Dinan, where he was a fellow student of Chateaubriand, who relates in the *Mémoires d'outre-tombe* (1819, **1**, 190) that while bathing there he was bitten by some ungrateful leeches which could not foresee his future. He took part in the war of La Vendée in which he contracted a severe attack of dysentery. On recovery he joined the Hospice Maritime at St. Malo as an *officier de santé*, a qualification now extinct, and shortly afterwards took up a similar appointment at Brest. During this time he served as a surgeon-major on board two privateers in the war with England and gained a considerable sum in prize money. Like Bretonneau, fifteen years later, he did not remain content with the modest title of *officier de santé*, and in 1799 went to Paris to complete his education, his chief teachers there being Pinel, Bichat, and Cabanis. After four years' study he obtained the doctorate of medicine with a thesis on hectic fever, which he dedicated to Pinel.

After two years' struggle with poverty as a private practitioner in Paris during which his total earnings were only 1,200 francs (Larcher), he accepted the proposal of Desgenettes that he should join the army, and during the next five years as an assistant surgeon took part in the Napoleonic campaigns in Belgium, Holland, Germany, Austria, and Italy. In 1808 he returned to Paris, and in the same year brought out his first important work entitled *Histoire des phlegmasies ou inflammations chroniques fondée sur de nouvelles observations de clinique et d'anatomie pathologique*, which he sold to a publisher for 800 francs. This work contained an account of inflammations in general followed by a description of inflammations of the lungs, including pulmonary tuberculosis, inflammations of the brain and inflammations of the abdominal viscera, accompanied by clinical records and post-mortem examinations of personal cases. The work did not attract much attention at first, but subsequently four more editions were published, the last in 1838, the year of his death.

At the end of 1809 he joined the army in Spain where he remained in the capacity of principal medical officer until 1814, when he returned to Paris. He was appointed the same year second medical officer and professor at the Val-de-Grâce Military Hospital, where six years later he became principal medical officer and senior professor in succession to Desgenettes. In 1816 appeared his most celebrated work entitled *Examen des doctrines médicales et des systèmes de nosologie, précédé de propositions renfermant la substance de la médecine physiologique*, which caused an

immense sensation in the medical world at that time. In this work after 468 aphorisms in which he set forth the doctrines of the physiological school, he dealt successively and for the most part unfavourably, with the work of Hippocrates, Galen, Celsus, Paracelsus, van Helmont, Boerhaave, Sydenham, Morgagni and Brown, medicine in Germany, England, and Spain, and contemporary medicine in Paris with special reference to Pinel, Laennec, Louis, Andral, Rochoux, Lallemand, and Bouillaud. In 1822 he founded a monthly journal entitled *Les Annales de la Médecine Physiologique* for the exposition of his doctrines, and continued to edit it until 1834 when owing to his appointment as professor in the Paris medical faculty he found it no longer necessary, and he invited his friends to contribute articles to the *Journal hebdomadaire des progrès des sciences et institutions médicales en Europe*, which was edited by Bouillaud, Forget, and Vidal.

In 1823 he became one of the first members of the Académie de Médecine which was founded in that year. Five years later he published his last important work entitled *De l'irritation et de la folie, ouvrage dans lequel les rapports du physique et du moral sont établis sur les bases de la médecine physiologique*, in which he endeavoured to substitute physiology for psychology in the study of intellectual and moral actions. The work was composed of two parts. In the first he discussed irritation in relation to health and disease with an enumeration of the various cerebral phenomena from the phrenological point of view; the second part contained a study of insanity according to the physiological doctrine and as a result of the phenomena of irritation. He had at this time, like his friend Bouillaud, become an enthusiastic supporter of the doctrine of Gall, and had been elected president of the Société de Phrénologie. Dubois (d'Amiens), the perpetual secretary of the Académie de Médecine, in an *éloge* of Broussais delivered ten years after his death, relates that the police had to interfere owing to the excitement caused by a rumour that he was going to deny the existence of God and the spirituality of the soul in his lectures on phrenology which attracted a huge crowd of students and society people, and the course was suspended. A compromise, however, was reached, and the authorities allowed him to continue his lectures in a room specially hired by his audience, where he asserted that he believed in God not like the ordinary man, from the bottom of his heart, but as a phrenologist should, with the anterior part of his brain. As regards the soul he was more recalcitrant, and declared that he could not undertake to defend it against the inductions of phrenology.

In 1831, owing to the support of his friend and patient, Casimir Périer, the president of the Council, he was appointed to a chair in the Paris Faculty of Medicine of general pathology and therapeutics that was specially created for him with a salary of 7,000 francs, and henceforth gave up his lectures at the Val-de-Grâce Hospital.

The cholera epidemic of 1832, to which he devoted a small monograph, gave him the opportunity of treating this disease, of which he had a large number of cases under his care at the Val-de-Grâce Hospital, by the antiphlogistic method, and his results, according to Reis, were certainly not more unsuccessful than those obtained in other hospitals at that time.

In his later years Broussais lost much of the enthusiastic support which he had enjoyed in the earlier stages of his career, as is indicated by the following description of him by Oliver Wendell Holmes in the thirties of last century :—

> " Broussais was in those days like an old volcano which has pretty nearly used up its fire and brimstone, but is still boiling and bubbling in its interior and now and then sends up a spirt of lava and a volley of pebbles. His theories of irritation and inflammation as the cause of disease, and the practice which sprang from them, ran over the fields of medicine like flame over the grass of the prairies. The way in which that knotty-featured, savage old man would bring out the word *irritation* with rattling and rolling reduplication of the resonant letter *r*—might have taught a lesson in articulation to Salvini. But Broussais' theories languished and well-nigh became obsolete, and this no doubt added vehemence to his defence of his cherished dogmas."

On the other hand a very different account is given as follows by Broussais' son, Casimir, and probably refers to a later period than that described by Holmes:

"One still remembers the course which Broussais delivered in 1836 in a lecture room given to him by his pupils who were too numerous for that of the Faculty of Medicine where the course had begun. Here the power of the orator was marvellously revealed. One saw again the spectacle of the literary and philosophic contests of the middle ages when the crowd of disciples thronged the buildings and squares to hear Abélard or St. Thomas Aquinas. . . . All his lectures were a series of triumphs and to perpetuate recollection of them his countless pupils had a gold medal struck with his portrait on one side and on the other the words *A l'illustre auteur de la Médecine Physiologique et du Cours de Phrénologie, ses disciples reconnaissants.* This fact is the best reply to those who do not hesitate to print that the orator's verve was exhausted in the last years of his life."

His death, which took place at his country house at Vitry on November 17, 1838, was due to carcinoma of the rectum which had been treated by Amussat, an eminent

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contemporary surgeon, who gives a detailed account of the treatment by dilatation with bougies, cauterization with silver nitrate stick and ligature and excision of portions of the tumour. The autopsy was performed by Levaillant and Foucart in the presence of Amussat, Bouillaud, Orfila, Casimir Broussais, and others.

Shortly before his death he had been engaged in preparing a reply to Jouffroy's attack on phrenology in the Académie de Médecine as well as in finishing a new edition of his work on *Irritation and Insanity* which appeared in 1839, under the editorship of his son Casimir Broussais. There was a rumour, probably due to the suddenness of his death, that he had been poisoned, but there do not seem to have

been any grounds for such a suspicion, and it appears to have speedily subsided (*London Med. Gaz.*, 1938–9, **23**, 344). He received a magnificent funeral at which Orfila, Boissy D'Anglas, and Droz were the pall-bearers. On arrival of the procession from his house at the Val-de-Grâce Hospital the students unharnessed the horses and dragged the hearse themselves to the cemetery of Père-la-Chaise where the speeches at the graveside were delivered by Bouillaud in the name of the Faculty of Medicine, Droz and Arago for the Institut de France, and Larrey *fils* for the Corps of the *Officiers de Santé* of which Broussais was a member. The French Government paid homage to his memory by the following message of condolence sent to his widow by the Minister of War: "Your illustrious husband leaves an immense gap among his colleagues and in the army a memory which will never die" (Dubois). On August 21, 1841, nearly three years after his death, a statue was unveiled in the courtyard of the Val-de-Grâce Hospital in which Broussais is represented in a sitting attitude trampling on the works of his predecessors whom he had so violently attacked.

Broussais was the recipient of many honours, both in France and in foreign countries. Bouillaud in his funeral oration applied to him what had been said of Boerhaave, that a letter from China addressed to "Broussais, Europe", would have found its destination. Besides being a Commander of the Legion of Honour and member of the Académie des Sciences Morales et Politiques, he was corresponding member of the Linnæan Society of Bordeaux, the Society of Emulation of Liège, the Societies of Medicine of Brussels and Breda, Honorary Associate of the Medico-Chirurgical Society of Cadiz and the Royal Academy of Medicine of Madrid and corresponding member of the Medical Societies of New Orleans and Philadelphia. The high esteem which Broussais enjoyed in foreign countries is also shown by the fact that several of his works were translated into English (*Histoire des phlegmasies chroniques. Traité de physiologie appliquée à la pathologie. Catéchisme de la médicine physiologique. Du cholera morbus épidémique*); Spanish (*Traité des phlegmasies chroniques, Examen des doctrines médicales. Catéchisme de la médecine physiologique*); and Dutch (*Du choléra morbus épidémique*).

The anonymous writer of his obituary notice in the *London Medical Gazette* of November 24, 1838, wrote of him as follows:—

"The author of the examination of medical doctrines—the founder of physiological medicine—the ardent defender of inflammation and leeches—has by the power of his systematical genius, by the energy of his convictions, by the vivacity and even violence of his controversy shaken medical theories to their foundation. During upwards of ten years he (the professor of the military hospital of Val-de-Grâce) had to maintain the most animated discussions. . . . Like all great reformers and founders of systems M. Broussais has done good and evil. Impartial history will apportion the share of each, but from this day we may safely enrol the name of Broussais among the glories of France."

Except to those specially interested in the history of medicine, the work and even the name of Broussais appear to be now almost unknown to medical men in this country where there is no hospital or street, as in Paris, which has been called after him. Over eighty years ago, however, his name appeared in the eighth edition of the *Encyclopædia Britannica* to which Laennec and Bretonneau, far greater figures in the history of medicine, were not admitted until the fourteenth edition published in 1929. It may also be noted that George Eliot in *Middlemarch* (published in 1873) makes the bright young Dr. Lydgate a former student of Broussais during his residence in Paris. Broussais, on his part, had little sympathy for the English, and regarded all the doctors in this country as old-fashioned, because they did not embrace his doctrines.

"The English", he exclaimed, "complain according to Lady Morgan of their short lives, but they should change their régime, they should stop gorging themselves with tea, alcohol and too substantial food; their doctors should abstain from purging them at every moment, instead of evacuating them by enormous phlebotomies which concentrate all the irritation in the alimentary canal a moment later, they should confine themselves to combating the inflammation by a few

capillary hæmorrhages, and one would no longer see in their country such a large amount of engorgements, spleen, hypochondria, melancholy and dropsy which shorten the lives of the youngest and most robust. It is chronic enteritis, that unrecognized and badly treated disease, which depopulates England " (Reis).

In his chapter on the state of medicine in England (*Examen des doctrines médicales*, 3rd ed., 1829, iii, 176) Broussais stigmatizes the English medical practitioners as ontologists and accuses them of ignoring the effects of drugs and diet. Moreover, he said, they bleed to excess, then give calomel, always neglect diet, and cause hyper-irritation of the gastric tract by ordering stimulants.

Broussais was a man of untiring energy, as was shown by his numerous activities as professor, writer, and consultant. He possessed a remarkable memory which enabled him to recite whole pages of Sydenham, and he knew by heart an enormous number of French and Latin verses. Contrary to what has been alleged by some of his critics, he was steeped in classical learning and was fond of literature and art (Montègre). According to De Montègre, who was his private secretary for several years, and therefore well qualified to speak on the subject, though liable to attacks of anger, especially in meeting with opposition to his views,[1] he was naturally tender hearted, and was devoted to animals.

Broussais is best known as the founder of so-called " physiological medicine ", in the history of which Saucerotte describes three distinct stages. In the first (1816–21) Broussais attacked the doctrine of the essentiality of fevers and developed his doctrine of acute and chronic inflammations. This was the period in which he was struggling to gain recognition. In the second stage (1821–28), which Saucerotte calls the period of organization, Broussais had won acceptance of his views and become chief of the physiological school, while the last stage was marked by an increasingly complete discredit of his doctrines. Broussais called his system " physiological medicine " because he wished to attach more importance to disorders of function than to anatomical changes. According to Faber, Broussais was the disciple of Bichat in so far as he sought to locate diseases in separate organs, though he deprecated the tendency to draw up definite clinical pictures of disease and to assign a typical course to each disease. All diseases, according to him, were due to irritability of the tissues and were aggravated by the action of therapeutic agents which exaggerated this property. He was far from underestimating the importance of local lesions in disease, but he regarded them not as the effect but as the cause to which all the symptoms were due, representing as they did " the cry of the suffering organ ", which in all cases was the same, viz. the stomach and intestines. Diatheses to Broussais were " imaginary entities and ridiculous ontologies ". Fevers did not exist, but were merely " febrile movements ", symptomatic of gastro-enteritis. There were no specific diseases. Cancer, syphilis, and tuberculosis were merely the end-result of chronic and often neglected inflammation of the alimentary tract. Malaria was simply a periodic gastro-enteritis.

As I pointed out in my paper on Bretonneau read before this Section over fourteen years ago, the doctrine of specificity is now so well established that it is one of the commonplaces of medicine, but it should be remembered that it is only comparatively recently that it has become so. Broussais was bitterly opposed to this doctrine and stigmatized as " ontologists " those who studied medicine from this point of view, and attempted to draw up definite clinical pictures of each disease. As, in his opinion, inflammation dominated pathology, he urged that an attempt should be

[1] The following story is told by Fée of his interview with a sick officer at Xeres who had transgressed the orders concerning his diet. " He stopped at the threshold, his face inflamed with rage, and striding up to the bed cried out in his loudest voice ' You have brought it on yourself, wretched man ! Very well, you will die ', and turning to those in attendance added ' We will dissect him, Gentlemen '. The patient shuddered, stammered out a few words and promised to be good, unhappily too late. He died a few days later, and when Broussais saw him in the post-mortem room he addressed the corpse with the words ' I told you so ', followed by a profound sigh."

made to prevent or at least combat it by an antiphlogistic regimen consisting in debilitants, revulsives, and more or less diffusible tonics. Debilitants, which he regarded as the most important, included a low diet, emollient drinks, and most of all general or local bleeding, especially by leeches. Emetics, purgatives, alcohol and mercury, he declared, excited the mucous membrane of the stomach and should be entirely discarded. Owing to his refusal to regard any disease as specific, he considered quinine as no more indispensable for malaria than mercury for syphilis or ipecacuanha for dysentery. The simplicity of the method and the forcible written and spoken language in which Broussais indulged gained him many adherents, and for nearly fifteen years physiological medicine was the predominant doctrine in Paris.

Triaire remarks that in 1820 medicine, as the result of Broussais' teaching, underwent a revolution which could only be compared to that produced by other reformers in the social and political world at the end of the eighteenth century. Broussais overthrew the system of Pinel and on its ruins constructed a system which Triaire says was as seductive in its simplicity as it was exaggerated in its exclusiveness and dangerous in its consequences. Reis remarks that the revolution caused by Broussais found followers even in America, but it was chiefly among the Latin races of France, Italy and Spain that his doctrine was welcomed. According to Garrison, Broussais' doctrine of irritation was taken up in Germany by Roeschlaub and occasioned a pale temporary reflex in the writings of Benjamin Travers, Pridgin Teale, and other English physicians of the period who ascribed many diseases to " spinal irritation ".

A formidable opposition soon arose of which the chief representatives were Bayle, Laennec, Bretonneau, Andral, and Louis. " What name ", says an anonymous author of Broussais' obituary notice (*Gaz. méd. de Paris*, 1838, **6**, 737), " has been more frequently uttered in one place with cries of admiration and in another with accents of hatred and disdain ? "

Andral in particular, as E. Chauffard points out, his successor in the chair of general pathology and therapeutics, proved by morbid anatomy that all medicine was not contained in the word " inflammation ", and that there were many organic lesions in the tissues that were not due to this cause. Moreover he found by post-mortem examination that in a large number of diseases there was no evidence of gastro-enteritis and that its existence had been assumed quite gratuitously. As the result of Andral's teaching medical opinion swung so much in the opposite direction to that of the physiological school that apart from the condition caused by corrosive poisons, the occurrence of gastritis, as Trousseau points out, was disputed even in Broussais' lifetime.

I have remarked elsewhere (1912) that a similar change in medical opinion took place about this time with regard to the incidence of gangrenous sore throat. Prior to the establishment of diphtheria as a specific disease by Bretonneau in 1826, the frequency of gangrenous angina was considerably overestimated, a large proportion of the cases so described being either examples of malignant diphtheria or, less frequently, severe forms of scarlet fever in which the rash had been overlooked or indeed non-existent. The influence of Bretonneau's teaching was so great that for many subsequent years the existence of gangrenous sore throat was denied, although a few eminent writers, Trousseau in particular, endeavoured to distinguish it as an independent condition.

The principal cause of the decline of Broussais' doctrines, as Reveillé-Parise points out, was that clinical experience did not confirm its claims. In spite of bleeding and low diet, cures were not obtained and convalescence was protracted owing to the exhaustion caused as much by starvation as by the disease itself. The physiological doctrine, as the anonymous French critic already quoted observed, was an exceedingly feeble conception, the success of which was partly due to the extreme simplicity of its principles and the apparent facility with which it was introduced into practice. Its

greatest merit, says this critic, was its liberal and reforming character. According to Broussais, to embrace his doctrines was to perform an act of liberation, while to combat it was to range oneself under the banner of obscurantism, Jesuitism, and the retrograde party.

The opposition between Broussais and his opponents was no doubt envenomed by a difference in their religious views, Laennec and Récamier, two of his principal opponents, being devout Roman Catholics while Broussais was a free thinker. In this connexion it may be noted that in his recent study of Récamier, Dr. Louis Sauvé, who is obviously *très bien pensant*, writes with some bitterness about the enthusiasm shown at the present day in France for the " médiocre Broussais ".

The strength of Broussais' conviction of the value of bleeding, in which he believed as firmly as Guy Patin did two centuries before, is shown by the fact that when suffering from indigestion he had himself bled six times to the amount of 20 oz., and had 15 applications of 50 to 60 leeches in the course of eighteen days in addition to *diète absolue* (Fosseyeux). As the result of Broussais' teaching, bleeding was not confined to fevers but was used for constitutional diseases as well. So popular indeed did the use of leeches become that a large number of persons employed them without consulting a doctor at all (Reis), and leeches became so fashionable that the trimmings on ladies' dresses were made to resemble them (Genty). The demand for leeches was so great that the supply in France became exhausted and importation of them from abroad took place on an enormous scale. According to Reis, English merchants profiting by the vogue which leeches enjoyed in countries other than their own, sought for them in Belgium, Holland, and Germany, and transported them to India and America where they were sold at prices ranging from 3 francs to a guinea each. Broussais practised bleeding not only on man but also on animals. On one occasion his friend Monnerey, on being shown some fighting cocks which Broussais had got from England at great expense, asked him to account for their wretched appearance. Their crests had lost their colour, and they could hardly stand upright. " I can't understand it ", said Broussais, " for I bleed them every week " (Babonneix). The extravagant use of leeches in therapeutics, though it survived longer than the other parts of Broussais' doctrines, especially in the hands of Bouillaud, who, as I have shown in my paper on that physician (1931), was also a *grand saigneur*, fell into disfavour as the result of the teaching of Louis and Chomel in France, Marshall Hall in England, and Skoda in Vienna.

M. D. E. H. Chauffard has drawn attention to the close resemblance between Broussais and another would-be medical reformer, John Brown. In the first place both showed a partiality for words which had seldom been used before, such as " medical doctrine ", " entity ", " phlegmasia ", " gastritis ", and " enteritis ". Secondly, Brown expressed opinions diametrically opposed to those of his illustrious predecessors and contemporaries such as Sydenham, Boerhaave, Stahl, and his own benefactor Cullen, with a harshness which at once gained the admiration of the masses. Broussais behaved in a similar manner to his predecessors and contemporaries, especially Pinel, Laennec and Louis. Thirdly, both reformers demanded a passive submission from their disciples in a manner which at once recalls the totalitarian spirit rampant in Europe to-day. Fourthly, both have been accused, especially Broussais, of literary dishonesty shown by plagiarisms from Haller, Baglivi, Bordieu and Bichat. On the other hand, while Brown maintained that 97% of patients owed their illness to asthenia and required stimulation, Broussais declared that 97% were sthenic and needed diminution of excitability, which made Laffont-Gouzy say that Broussais' " physiologism " was only " Brownism " turned inside out. According to Reis, who was his clinical assistant for eighteen months, Broussais was much less exclusive at the bedside than he was in his writings or his lectures. Similar evidence is afforded by the young Trousseau, who in one of his letters to Bretonneau (Triaire, **1**, 544) relates that Broussais had six typhoid patients under his care who were all treated

in the same way and all recovered. " Do Broussais the justice of believing ", Trousseau continues, " that if as a theorist he is a brute (*animal*), as a physician in serious diseases he knows how to look after his patients." On the other hand, as Trousseau relates, Husson, one of the most devoted partisans of the physiological doctrine, lost two thirds of his typhoid patients by too strict an application of the antiphlogistic régime. Less harm indeed was done by Broussais himself than by his fanatical pupils who discarded the use of such valuable specifics as cinchona for the treatment of malaria and ipecacuanha for dysentery.

In Broussais' favour it has been urged that his works possess originality.

" No one ", says the anonymous French critic already mentioned, " has better justified the maxim that the style is the man. One must not look for any literary elaboration or refinement. Even in his last works there was something crude and unfinished. Though an accomplished writer, his language showed a lack of delicacy. On the other hand, apart from the philosophic reflexions which appear in his work on *Irritation and Insanity* and which are quite unintelligible, his writings possess a remarkable lucidity. . . . No one did more to discredit vague and obscure systems and the pedantic and hollow phraseology of the old schools and to regard precision of language as synonymous with that of ideas."

" In conclusion " the critic remarks that " it was not his special theories nor his therapeutic principles which we recommend, but merely the spirit of independence and examination which he introduced into the Paris school, and of which he was the first victim."

Poullain, one of his assistants, though at first attracted by the antiphlogistic doctrine, afterwards saw that it had few advantages over former methods, and that it had often fatal results. He admitted, however, that Broussais never starved his patients, as was asserted by some malevolent critics, though this was done by the " ultra-physiologists ", who claimed to be his partisans, but was always ready to satisfy the demands of those who asked for food.

Among recent authorities who have a word to say on Broussais' behalf should be mentioned the late Professor Joseph Grasset of Montpellier, who writes :—

" After Bayle and Laennec one must mention Broussais, who was an extremely energetic worker in the building up of morbid anatomy. His exaggerated expressions, the violence of his polemics, were merely the defects of his qualities, the dangers of his system which were aggravated by his pupils, should not let us forget his real work and the impulse which he gave to pathological research. One may say that in many aspects his *History of Chronic Phlegmasias* has rendered an immense service to medicine."

J. B. Fonssagrives, another eminent physician of Montpellier, remarks that in spite of his erroneous doctrine of gastritis, Broussais, by substituting the doctrine of local irritation for diatheses, replaced the abstract by the concrete and gave a character of precision to practical medicine which had hitherto been lacking.

Lastly it may be said in defence of Broussais, that possessing as he did all the qualities of an apostle he derived no pecuniary advantages from his doctrines, and he died, if not poor, at least with only a very moderate fortune (Maljean).

REFERENCES

Amussat, J. Z. (1838), *Gaz. méd. de Paris*, **6**, 769.
Andral, G. (1829), " Précis d'anatomie pathologique ".
Id. (1839), *Clin. méd.*, **2**, 3. Paris.
Babonneix, L. (1938), *Gaz. d. hôp.*, **111**, 1221.
Bonnette, F. (1938), *ibid.*, **111**, 1344.
Bouillaud (1838), *ibid.*, **12**, 565.
Boyer, L. (1870), " Dict. encycl. sc. méd ". (Dechambre), s. v. Broussais. Paris.
Broussais, C. (1839), Preface to " De l'Irritation et de la Folie ". 2nd ed.
Chauffard, E. (1877), " Andral. La médecine française de 1820 à 1830 ".
Chauffard, M. D. E. H. (1839), *Gaz. d. hôp.*, **12**, 13.
Dubois, F. (1849), *Mém. Acad. Nat. de méd.*, **14**, 1.
Faber, K. (1923), " Nosography in modern internal medicine ". New York.

FÉE, A. L. A. (1856), " Souvenirs de la guerre d'Espagne ", p. 310.
FONSSAGRIVES, J. B. (1861), " Hygiène alimentaire des malades ". Introd. xxxviii. Paris.
FOSSEYEUX, M. (1930), " Il y a cent ans. Paris médical en 1830 ". Paris.
GALLOIS, P. (1938), *Hippocrate*, **6**, 406.
GARRISON, F. H. (1929), " An Introduction to the History of Medicine ". 4th ed., p. 410.
GENTY, G. (1938), *Progrès méd.*, Suppl. illustré, April 2, **65**, p. 30.
GRASSET, J. (1911), " Idées médicales ", p. 310.
HOLMES, O. W. (1883), " Medical Essays ". 2nd ed., p. 429.
HUET, J. (1938), *Thèse de Paris*, No. 556. " Broussais. Sa Vie et son Œuvre."
LARCHER (1938), *Progrès méd.*, Suppl. illustré, April 2, **65**, p. 25.
LEMÉE, P. (1938), *Paris méd.*, Partie paraméd., December 10, ii, **28**.
MALJEAN (1927), *Chron. méd.*, **34**, 99, 131.
MONTÈGRE, H. DE (1829), " Notice historique sur la vie, les travaux, les opinions médicales et philosophiques de F. J. V. Broussais ". Paris.
POULLAIN, J. B. I. (1826), *Thèse de Paris* No. 54. Des médecins physiologistes, et de leur doctrine.
REIS, P. (1864), " Etude sur Broussais et sur son œuvre ".
REVEILLÉ-PARISE (1839), *Gaz. méd. de Paris*, **7**, 353.
ROLLESTON, J. D. (1912), *Antiseptic*, **9**, 533.
Id. (1924), *Proc. Roy. Soc. Med.*, **18**, Sect. Hist. Med., 1.
Id. (1931), *ibid.*, 24, 1253 (Sect. Hist. of Med., 37).
SAUCEROTTE, C. (1855), " Nouvelle biographie générale ", **7**, 536.
SAUVÉ, L. (1938), " Le docteur Récamier (1774–1852) ". Paris.
TRIAIRE, P. (1892), " Bretonneau et ses correspondants ", **2**, 200. Paris.
TROUSSEAU, A. (1862), *Clin. Méd. de l'Hôtel Dieu de Paris*, **2**, 393.

Section of Dermatology

President—H. Haldin-Davis, F.R.C.S.

[*December* 22, 1938]

Case for Diagnosis: ? Pringle's Disease.—Godfrey Bamber, M.D.

Mrs. C. L., aged 50, about fourteen years ago noticed on the face the appearance of lesions which slowly increased in extent until about five years ago, since when their progress has been more rapid. One sister is said to be similarly affected, and lesions are beginning to appear in a second sister.

Scattered over the face and neck are numerous firm, whitish, pin-head to pea-sized papules, which are less prominent in the central area of the face. The larger ones have been coagulated by diathermy. The diagnosis was thought to be epithelioma adenoides cysticum, but this was disproved by the report on a section of a papule on the forehead.

It might be added that there are no fits in the family. Patient states that her father had a few small papules on his forehead.

Pathological report on Nodule from the Forehead (W. Freudenthal, M.D.)

Epidermis and appendages.—The epidermis is thin with the rete pegs almost completely flattened out. In place of hair follicles are deep horny recesses with dilated ostia, hairs are absent, only exceptionally is a very thin one found. Sometimes epithelial strands arise from these horny dimples. No sebaceous glands were found (in more than 60 sections).

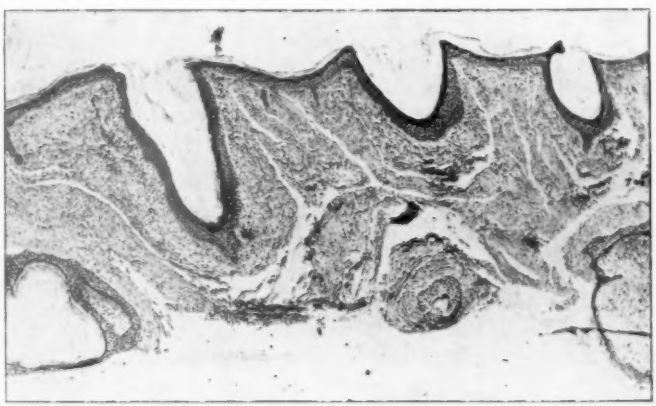

Fig. 1.—Horny recesses in place of hair follicles. Normal collagen tissue replaced by masses of fine wavy fibrils. Oblique fissures running through the cutis. (× 40.)

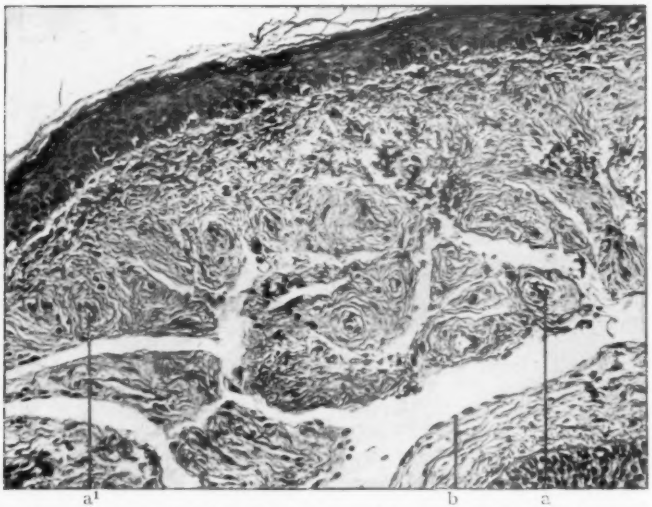

FIG. 2.—Fine wavy fibrils often concentrically arranged and frequently showing a capillary vessel in the centre (a, a¹). Fissures with partial lining of endothelium (b). (× 160.)

Cutis.—The normal collagen tissue has disappeared and is replaced by a peculiar connective tissue of fine wavy fibrils often concentrically arranged and frequently showing a capillary vessel in the centre. Running through the cutis are a number of oblique fissures some of which in places have an endothelial lining. Elastic fibres are entirely absent.

Adenoma sebaceum, the name given by Pringle, was somewhat unfortunate. The sebaceous glands in his case were numerous and large; there was a hypertrophy but not an adenoma of the sebaceous glands. Nor did any of the cases reported later show an adenoma. It was found, however, that the little tumours in this disease showed a wide variety of histological changes, a classification of which was first attempted by Winkler.

This case may be put with Darier's fibro-angiomatous tumours which he originally considered to be different from adenoma sebaceum, but which we now regard as a variety of Pringle's disease. The special interest in our present sections lies in the whorled fibrous tissue reminiscent of the fine fibrillary arrangement seen in Recklinghausen's neurofibromatosis. It lends support to the idea first expressed by Hintz that there is a genetic link between the diseases of Pringle and Recklinghausen, in both of which structural changes of the nervous system may be combined with tumours of the skin.

References.—WINKLER, M. (1903), *Arch. f. Dermat. u. Syph.*, **67**, 3; DARIER (1890), *Bull. Soc. franç. de dermat. u. Syph.*, **1**, 146; HINTZ, A. (1911), *Arch. f. Dermat. u. Syph.*, **106**, 277.

Lichen Planus in Lines from Scratching.—F. PARKES WEBER, M.D.

The patient, H. R., an unmarried woman, aged 23, is almost constantly subject to a slightly irritating dermatosis of the right hand and lower part of the forearm, consisting, in its most characteristic parts, of thin, slightly raised, reddish or white lines, with a shiny or somewhat scaly surface. These lines tend to appear a day or so after scratches, whether these be accidental or self-inflicted on account of

irritation. The trouble commenced about nine years ago and was at first confined to the index finger.

Apart from stammering and a little tendency to urticaria factitia, there appears to be no other abnormality in this patient. There is no blood-eosinophilia.

An alternative diagnosis, suggested by the appearance of the finger-webs, is the possibility of linear plane warts. There has been no biopsy.

Discussion.—Dr. W. FREUDENTHAL (for Dr. Parkes Weber) said that Dr. Parkes Weber himself was somewhat doubtful about the diagnosis. The clinical appearance has varied, almost disappearing at times. No biopsy had been made.

Dr. A. M. H. GRAY said that on examining the case he did not see any lesions typical of lichen planus. He thought it was a case of lichenification.

Dr. W. J. O'DONOVAN said he had been informed that this patient had been for a long time a counter hand at a popular chain stores. For long periods at a time she handled scented bath salts, soaps, sugars, and sweets. It was impossible now to say what the original diagnosis should have been. The lesions to-day were much paler than lichen planus, although they had a flat papular appearance. These papules were aggregated with no linear or circular patterning at all. It was probable that to-day she was suffering from a chronic sensitization dermatitis and that this would persist for some time yet.

Dr. A. C. ROXBURGH said that he agreed with Dr. Gray that this was a case of lichenification due to scratching.

Angioma Serpiginosum.—F. PARKES WEBER, M.D.

The patient, A. E. F., a young unmarried woman, now aged 33, has small red and reddish-brown lesions, some "lichenoid" with a shiny surface, mostly arranged in groups, on the hand, forearm and upper arm, on the right side. The case was shown in March, 1927, when the patient was 21½ years (*Proceedings*, **20**, 1341). The appearances have changed little since then, and this case is therefore neither Schamberg's disease, Majocchi's purpura telangiectodes, nor lichen planus. Slight examples of the condition, like this one, are usually unilateral or asymmetrical and not symmetrical, as was suggested by Jadassohn ("Dermatologie", 1938, p. 452).

Pigmented Nævi on the Skin, Lips, and Buccal Mucous Membrane.—G. B. MITCHELL HEGGS, M.D.

R. S., female, aged 18. Occupation: Domestic.

Previous history.—Nothing relevant, except these spots since infancy.

Patient complains of disfigurement and requests removal of the nævi.

Present condition.—There are numerous small, pigmented macules distributed in the following areas: round the eyes and mouth and on the lips; nape of the neck, elbows, back and thighs, knees and backs of hands. There are also similar pigmented lesions on the buccal mucous membrane of the lips and cheeks.

A biopsy of skin taken from a lesion at the edge of the lip to include the mucous membrane, shows multiple pigmented cells in the deepest layer of the epithelium, and melanophores are also present in the fibrous tissue.

Discussion.—Dr. A. C. ROXBURGH said that he had seen a similar case at St. John's—a woman with pigmented macules on the lips and inside the mouth. So far as he remembered, no treatment was advised because it was not thought that it would be helpful. The lip lesions were the only obvious ones in that case.

Dr. LOUIS FORMAN said that he had one case similar to this in a middle-aged woman, who gave quite a short history—only a few years—and as far as he remembered there were no nævi elsewhere.

Dr. HEGGS said that Dr. Dowling's case, to which he had referred, had a strong family history; there were two relatives who were known to have the same condition. He agreed with Dr. Roxburgh, he did not intend to treat the lesions in the mouth, only those on the skin.

I.—Case for Diagnosis. ? Periadenitis Mucosa! Necrotica Recurrens (Sutton).—J. H. TWISTON DAVIES, M.B.

Woman aged 34. First seen 20.7.38, complaining of an ulcer at the right angle of the mouth of four weeks' duration. She had had a similar ulcer in about the same place six months previously, of which the scar, bounded by a thread-like waxy ridge, was still visible. The present lesion had been painful in its early stages and had been thought to be a tuberculous ulcer. The ulcer, on the upper lip near the commissure, was irregular in outline, deeper than it was wide, and had a ragged, sloughy base. The surrounding tissues were firmly indurated.

Wassermann reaction negative. Physical examination, sputum and skiagrams negative for phthisis.

Section showed œdematous but densely cellular granulation tissue with a few giant cells but no tuberculoid systems. The biopsy seemed to expedite healing for this took place within ten days.

When the patient was seen again on 14.12.38 there was a firm tender swelling a centimetre away from the commissure of the lower lip. In appearance it suggested a very localized area of intense inflammation in the deeper layers of the lip, bulging but not otherwise affecting the surface. She was given an exposure of X-rays and a large dose of quinine in the hope of aborting it.

To-day the ulcer has developed and is covered with an adherent laminated crust. If one removed this the cavity of the ulcer would be seen to be filled with an opaque whitish jelly-like slough.

The condition seems to correspond with that described and illustrated in Sutton's textbook. Elsewhere (Sibley, 1899, Löblowicz, 1910) it has been labelled ulcus neuroticum and stress laid on the neurotic personality of the patients. This particular woman is an emotional person but in two other cases I have seen recently I believe the psychological factor could be excluded.

Clinically one has the impression of infarction of a small artery followed by necrosis of an inverted cone of tissue. The lesion would appear to be too deep for an infection of a mucous gland. A case I treated with a herpes virus vaccine was not improved.

The Handbuch article entitled " recidivierenden aphthen " describes this condition but oddly enough it is illustrated with a coloured representation of Case II with the legend " ulcus neuroticum."

II.—Case for Diagnosis. ? Ulcus Neuroticum.—J. H. TWISTON DAVIES, M.B.

Woman, aged 62. First seen 24.6.38, complaining of ulceration of hard palate of two months' duration in the position of the suction pad of her upper denture. Her dentist had assured her that the denture had nothing to do with the ulcer. The ulcer then consisted of a mass of hypertrophic granulations. Patient was simply instructed not to wear the denture. Seen a week later, the ulcer had the aspect of a rapidly healing erosion. The base, level with or slightly raised above the edges, consisted of fine granulations, red and of healthy appearance, while at the border epithelialization was obviously proceeding apace.

A week later again the same picture was observed, but the ulcer had altered in shape and position. The patient has been seen five or six times since, and each

time the ulcer, always more or less the same in size, has been entirely different in shape and position within the confines of the left half of the palate.

21.11.38: A similar ulcer appeared in the buccal surface of the left cheek. On the opposite cheek there were some little stellate patches of leucoplakia.

Patient complains also of a chronic discharge from the right nostril, thirst, and a nasty taste in the mouth. Otherwise in her usual health; plenty of energy, no definite indigestion.

Wassermann reaction negative. No sugar in urine. Bacteriology of ulcer: Normal buccal flora.

She has had no treatment beyond a full and varied diet with added vitamins.

Section shows a non-specific granulation tissue containing a fair number of mast cells.

This patient again is not of the neurotic type. She leads an extremely active and useful life keeping house for a retired captain. She also washes and greases his car. At one time I entertained the suspicion of an artefact but two aurists who have seen her scouted this possibility.

Discussion.—Dr. W. N. Goldsmith said at present he thought the second case looked most like lichen planus of ulcerated type, but the fact that the ulcer moved about rendered that diagnosis unlikely. He also asked where Dr. Davies obtained herpes vaccine for the treatment of his case. He (the speaker) had treated some cases of herpes with ordinary calf-lymph, apparently with success, but he had not used specific herpes vaccine because he had not known that it was easily obtainable in quantity.

Dr. A. M. H. Gray said that Case I, that of the younger woman, was quite typical, from the description Dr. Davies gave, of that curious condition which for simplicity might be called "Sutton's disease." About fifteen years ago he showed a very similar case to the Section,[1] and the patient was in a much worse state at the time than was Dr. Davies' patient. She had a number of sharply punched-out ulcers scattered through the mouth on the tongue, lips, and pharynx, though he did not remember that she ever developed any on the palate. She had these for a considerable number of years. She was sent to him by Dr. Nabarro, pathologist at Great Ormond Street, who had made a bacteriological examination of the case and found nothing of importance. These cases seemed very intractable. He could not find any treatment which had an effect upon them. When his case was shown Dr. Sibley thought the condition was one of neurotic ulceration of the mouth. He did not think the first of Dr. Davies' cases belonged to the same category, and he was not prepared to give an opinion as to its nature.

Dr. Twiston Davies (in reply to Dr. Goldsmith) said that when he saw the patient on the last occasion she had already had the ulcer for four weeks. It healed within a fortnight, much to the surprise of the patient, who was kind enough to attribute the improvement to the biopsy.

The herpes vaccine he obtained from Dr. Beatrice Lewis.

Dr. O'Donovan said that Case I affecting the right lower lip, was one of great rarity. He was much obliged to Dr. Twiston Davies for exhibiting it. In this case everything depended upon the history. Concerning Case II with ulceration in the mouth, it was certain that young people with teeth and old people without teeth, if they felt a buccal irritation, would champ their jaws or mumble their gums without rest. He was inclined to believe that this case was one of the type shown by Dr. Knowsley Sibley, and he thought that the implication of a neuropathic background of the ulceration held the field. On being questioned the patient said that she had noticed a recurrence of little blisters. If this could be relied upon, then here was a definite herpetic pathological lesion that would give rise in some patients to stomatitis ulcerativa neurogenica.

Dr. Twiston Davies said that he had looked carefully for blisters but had never seen anything suggestive of one. On only one occasion had a new lesion developed—the one on the left cheek What happened was that the ulcer extended in one direction while healing in another. The lesion might well be described as a wandering geographical ulcer.

[1] *Proc. Roy. Soc. Med.* **1923**, **17**, Sect. Derm. 57.

POSTSCRIPT.—On the morning after the meeting the patient came to see him with a similar ulcer in the buccal surface of the right cheek. He hopes to obtain the report of a psychiatrist and will communicate this at a later date.

Senear-Usher Syndrome.—I. MUENDE, M.B.

E. B., male, aged 64.

The eruption began in the middle of August 1938 with what patient thought were two bites on the right forearm. Then irritated and flaccid blisters appeared rapidly and remained for a week. The blisters were only sore on pressure, and when they burst, their bases were dry, and he complained of severe local irritation—as if he were wearing a "sand-paper shirt". The lesions in this first attack almost completely disappeared after three weeks, and then the blisters reappeared in the same situation and also on the batswing area of the face, conchæ of the ears, backs of both hands, and a few isolated larger ones on the lower abdomen and legs. The onset of this attack was associated with severe puffiness of the face.

When first seen on 12.11.38 he had several discrete adherent scaly lesions on the batswing area of the face and in the conchæ of the ears, and large oval pink scaly patches on the trunk and legs; there were a few large and numerous small violaceous, slightly raised lesions on the sides of the wrists and on the backs of the hands which were suggestive of both lichen planus and lupus erythematosus. He was given Mist. Fowler ɱv t.d.s. and during this time the rash became much less obvious, the patches on the trunk changing to a brownish colour with central irregular areas of a bluish-red. At no time were there any mucosal lesions. Wassermann reaction negative.

If this is a case of Senear-Usher syndrome, it must be very rare in this country.

Since I wrote the description the condition has changed considerably, the patches on the face have disappeared completely except for a faint lesion at the left inner canthus and a few scattered over the left temple. The lesion on his right wrist now suggests lupus erythematosus rather than lichen planus.

The histology showed very interesting features which I had not encountered before. There was marked acanthosis with the production of pear-shaped rete pegs, the basal layer of which was composed of small cells of irregular shape. Those of the rete malpighi were very enlarged, their nuclei frequently having two large nucleoli, and it was not unusual to find a large nucleus with a dividing membrane without any evidence of nuclear division. Occasionally one found large pinkish nucleoli which appeared to grow into larger acidophilic bodies occupying a large part of the cell and pushing the nucleus to one side. In other words, one had the impression that the condition was due to a virus which acted upon the cell nucleus.

In the upper part of the corium there was considerable destruction of elastic tissue which was swollen and fragmented. A most unexpected feature of the histology was a complete lack of resemblance to lupus erythematosus.

Further histological preparations will be made from other lesions and reported to the Section at a later date.

Discussion.—Dr. A. M. H. GRAY said that in February last[1] he showed a case which he had labelled Senear-Usher syndrome, and at the same time a case of pemphigus foliaceus, and he gave some reasons why he thought the two conditions were the same. The Senear-Usher case eventually developed into a complete pemphigus foliaceus. With regard to the present case shown by Dr. Muende, this seemed to be getting better so far as he could see, and it was difficult now to give an opinion on it. It was clear that their American colleagues had had great doubts about this condition, but opinion in the States seemed to be moving towards pemphigus and away from lupus erythematosus.

[1] *Proceedings* (1937-8), **31**, 871.

Dr. R. KLABER said that he had ventured some time previously to show before the Section under this somewhat dubious label, a boy whom Dr. Gray had subsequently treated at Goldie Leigh Hospital. His face was almost covered with bullæ and crusts of many months' duration, and he was a K.L.B. carrier. It would be of interest if Dr. Gray could give any further information regarding this boy.

Dr. A. M. H. GRAY said that when he last saw the boy, who was a mentally defective child and rather a troublesome one and had to be transferred to another hospital, he regarded him as one of those cases of pemphigus in children—with which members would be familiar. He thought his case was identical with the other cases he had had at Goldie Leigh, the majority of which got quite well. Of seven cases he had seen there with this condition, all except one, had definitely cleared up. That also was his experience at Great Ormond Street. The cases behaved exactly like ordinary cases of chronic pemphigus except that they got well.

Melanodermia ? Pigmentary Morphœa.—ROBERT KLABER, M.D.

Patient, female, aged 18 ; in good health. About eight years ago the appearance of brownish-black macules was first noted, and they have since gradually increased in size and number until an extensive area of the trunk is covered by them. On the front of the abdomen there appears to be a well-marked limiting line, corresponding

Melanodermia ? Pigmentary Morphœa.

with the lower part of the mid-abdominal line. There is also a patch on the middle of the left inner thigh about 2 in. in diameter which, like some of the abdominal lesions, shows within the affected area, white follicular spots.

Mucous membranes show no pigmentation.

Blood-pressure taken at the first examination : 160/90.

Only one patch on the right scapular region shows a halo suggesting slight infiltration.

Dr. A. C. ROXBURGH said that the case reminded him very much of one which Dr. Corsi showed to the Section on his behalf some years ago (*Proceedings*, 1931, **24**, 685, Sect. Derm., 39), that of a woman who came to him with large, more or less symmetrical, atrophic, pigmented patches on the trunk. This was the condition when he first saw her, but by the time she was shown to the Section she had developed, in addition, a typical patch of morphœa on the abdomen, and Dr. Parkes Weber said that she was a case of atrophic scleroderma.[1] On the strength of that case he would be prepared to say that the present case shown by Dr. Klaber was one of atrophic scleroderma.

Verrucose Tuberculide.—HUGH GORDON, M.C., M.R.C.P.

The patient, a man aged 45, has suffered from tuberculosis of the lungs for many years : this is at the moment active. About twenty years ago he remembers cutting his hand and sucking the wound. This subsequently healed but lasted rather longer than is normal. On its site there appeared what he describes as a " wart ". It was at this time that the diagnosis of tuberculosis of the lungs was made, tubercle bacilli being found in the sputum. The original wart disappeared and left no scar, but the lesion appears to have spread distally from its site.

He now exhibits a serpiginous verrucose tuberculide on the dorsum of the hand which in two places has spread forward to the knuckle.

Wassermann reaction was negative. The lesion has had no treatment of any sort : spontaneous healing takes place, with practically no scarring, but with progression elsewhere.

The case is interesting as an illustration of a verrucose tuberculide apparently acquired by auto-infection.

[1] A photograph of this case is shown as fig. 158 in " Common Skin Diseases," 4th edition, by A. C. Roxburgh.

Section of Epidemiology and State Medicine

President—J. A. H. BRINCKER, M.B.

[*January* 27, 1939]

DISCUSSION ON EPIDEMIOLOGICAL PROBLEMS OF POLIOMYELITIS IN SCHOOLS

Anterior Poliomyelitis and Polio-Encephalitis

By R. E. SMITH, M.B.

Medical Officer of Rugby School

THE recent increase of reported cases of poliomyelitis makes this a timely discussion [1]. I do not know whether this rise (Table I) is due to the notification of abortive as well as declared cases. If it is, it may be better in future if we discriminated between the two types of cases on the notification form. The general incidence of the disease at school is low. In the five-year period 1929–34, into which the Medical Research Council has been carrying out an investigation of illness in public schools in an average population of 10,270 boys and 3,503 girls, there have only been five cases, two at one school in 1932 and one definite and two probable cases in another [2]. The next table (Table II) shows the result of a questionnaire by the Medical Officers of Schools Association in 1932; this extends over a period of twenty years and 51 replies were received from 104 schools [3].

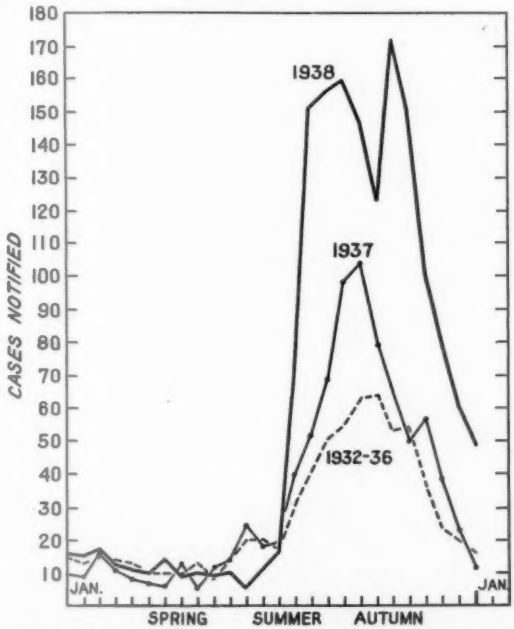

TABLE I.—Number of notifications of poliomyelitis and polio-encephalitis in fortnightly periods.

(From *Lancet*, 1939 (i), 176. Reproduced by permission.)

TABLE II.—RESULTS OF QUESTIONNAIRE BY MEDICAL OFFICERS OF SCHOOLS ASSOCIATION IN TWENTY YEARS (1912-32).

104 *schools interrogated:* 51 *replies received.*

	Population	Age	
10 girls' public schools	2,000	13–19	No cases
11 answers from preparatory schools' M.O.s	Not stated	9–13	No cases
30 boys' public schools	10,000	13–19	No cases in 11 32 cases in 19

Analysis of the 32 *cases.*

Year		
1918	1 epidemic of 4—all in one house which was isolated	1 death 1 recovery 2 residual paralysis
1919 1926	2 epidemics of 3	(i) 2 recoveries; 1 partial paralysis (ii) 3 recoveries
1926 1932 1932	3 epidemics of 2	(i) 1 death; 1 recovery (ii) 1 recovery; 1 partial paralysis (iii) 2 recoveries

16 single cases (2 deaths)

These statistics may help to fortify those who have not had an epidemic, but they are cold comfort to medical officers who have had to cope with an actual outbreak. A questionnaire is never the best, though it is sometimes the only means of getting information. This one had two defects: Firstly, the Broadstairs schools which had been the subject of a recent epidemic were not included, although several of the medical officers to these schools were members of the Association; secondly, records in some schools were not sufficiently well kept to give the correct information. This at least refers to one school, where the medical officer in 1931 stated, in perfectly good faith, that there had been no cases in the last twenty years. He was proved to be incorrect, and my thanks are due to one of the victims for his help in tracing the history.

The following epidemic occurred at Bradfield College, Berks, in 1918. I am indebted to Dr. F. A. Brodribb, who was then Medical Officer to the School, for this account, and to the present Headmaster for permission to publish it.

Influenza which raged over Europe in 1918 was of the utmost severity in Bradfield, the first case occurring in the village on October 14, 1918. It reached the College about the first week in November, and the Medical Officer himself was in bed with it on Armistice Day. On his return to work on November 14 he found that influenza was making rapid strides and that no fewer than seven boys had poliomyelitis. It had been impossible to get a locum tenens and these cases had occurred in five days. No one, therefore, observed the cases in the first few days. He believed they all came together and none occurred afterwards, although in a week the whole school went down with influenza.

The seven boys were from 14 to 17 years of age. The youngest had it badly in one arm, two had a very severe attack affecting the trunk muscles and the quadriceps extensor and anterior tibial group: one of these had a pneumothorax. A fourth had the small muscles of the hand and the deltoid affected, and details of the others are not remembered.

The following term an eighth boy was brought to the notice of the Medical Officer, with a slight weakness of the extensors of one hand.

These cases were not confined to one house or one dormitory or classroom. They were seen by Sir Thomas Horder and by Dr. Turney, who concurred in the diagnosis.

The recent outbreaks at Wellington and Felsted both warrant the term "epidemic." I have collected from the literature twelve other outbreaks in schools and colleges, but I will only quote four of these in detail.

The Sevenoaks epidemic.—Apart from the Broadstairs epidemic, this was the first to be reported as occurring in a residential school. In May–June 1929, over a period of seven weeks, 15 individuals were attacked out of a total of 75. The school was a co-educational one situated a quarter of a mile from a small country village and standing in its own grounds. There were 11 teachers, 56 pupils, and 8 domestic staff. There was no other illness in the school at this time. Pharyngitis occurred in every case. This feature contrasted sharply with the other protean symptoms.

Description of the epidemic: The school term commenced on May 8. The following day a boy of 8 developed an abortive attack. It was thought that customers stopping at his father's garage were responsible for the infection. On the first night of his illness he and a boy aged 12, suffering from burns, slept in the sick room in beds 4 ft. apart. On May 16 the older boy was attacked by polio-encephalitis with left facial paralysis. On the first night of term the younger boy had slept in a bed 1 ft. away from a boy aged 8½, who developed an abortive attack on May 17, and during the first two days of term at meals he sat next to a mistress aged 26, who developed an abortive attack on May 17. She did not report sick. This mistress shared a room and spent most of her time with another mistress who was taken ill on June 10, and had an abortive attack with spinal stiffness as the chief manifestation.

A girl aged 8, taken ill on June 9, developed a severe attack which ended fatally. She was isolated on that day. Next to her sat a girl of 8½, who developed prodromal symptoms on June 13 and a palatal weakness on June 16.

Contact infection was not traceable in the remainder, but the fact that a mistress who had an abortive attack was at work for from five to six weeks, leaves no doubt that there was plenty of opportunity for it. In all, 15 cases occurred, with one fatality. Eight of these were abortive and seven showed involvement of the central nervous system, in which term is included meningitic irritation. The diagnosis in some cases was undoubtedly questionable on clinical grounds, but it was confirmed by the neutralization test on monkeys in several of the abortive cases and in some of the close contacts.

No case occurred among the house boys. There was one other case in the district at this time, but no connexion could be traced.

Outbreak in a residential school.—In a residential school of 88 boys from 10–18, six weeks after the commencement of terms, 11 boys were suddenly taken ill between June 10–20, 1933 [5]. Five were completely cured in two to six days, two after a longer period, and four were attacked with paralysis, one of whom died after a four-days' illness. The community was practically isolated and there was no other disease before or after the outbreak. The chief contact seems to have been at meals, cases 1 and 2; also cases 3 and 11, sitting next each other; cases 3 and 7 diagonally opposite; only one boy separated cases 6 and 9 and also 5 and 8; and two boys separated cases 2 and 4 and also 4 and 10.

No serum was used. Two were 11, two 12; two 13; three 14; and two 15 years of age. All had paralysis at the same time.

E. C. Rosenow [6] described an epidemic which occurred at a college attended by 479 men and 448 women. Seven to ten days before the epidemic there were many cases of nasopharyngitis characterized by moderate hyperæmia of the throat, often associated with loosely adherent greyish phlegm in the pharynx, which was not present when these patients were examined six to eight months later. Associated with the pharyngitis were unusual types of headaches, girdle pains in the lower part of back and in the thorax, stiffness and pain in the neck or in one or more extremity. Fever was usually absent.

This was followed between October 25 and 30, 1930, by eight cases of poliomyelitis. Two of these died, three more had paralysis and three, diagnosed in the preparalytic stage by lumbar puncture, aborted. The exact dates are not given. Three were freshmen, four were sophomores, and one was a senior. Infection by contact could

not be proved and the evidence produced strongly points to the unpasteurized milk as being the source of infection. The author expounds the " poliomyelitic streptococcal " ætiology of the disease, a view which is not generally accepted.

The Broadstairs epidemic is the largest on record affecting a school population [7]. In 1926, 74 cases were diagnosed, 62 notified, and there were seven deaths. The next tables (III and IV) will show very briefly the attack rate upon different schools.

TABLE III (GROUP I).

A. The first school attacked contained 73 boarders. 12 were attacked. All had paralysis and two died.

B. 21 boarders. Five cases (all paralytic).

C. 21 day boys, three boarders. Three cases among day boys (one fatal) ; also brother-in-law of Headmaster.

D. 28 boarders. One abortive, one paralytic case, on same day.

F. 74 girls (boarders). Assistant mistress died on October 14. Two girls in this mistress's class subsequently developed anterior poliomyelitis. A domestic servant got polio-encephalitis.

G. 53 girls (boarders). Three cases.

School F, with the mistress, attended the morning service at a certain church at 11 a.m. on October 10 and occupied seats just vacated by schoolboys of School B, who attended a special service at 10 a.m.

And School G attended the afternoon service and occupied seats occupied by Schools B and F.

TABLE IV (GROUP II).

The second group were chiefly day pupils.

E. 25 boarders, 18 day boys. October 11—two cases (boarders), one paralytic, one abortive. A younger brother of a day boy attacked.

October 16. This school attended the same church as B, F, H.

H. In the school itself, five paralytic and one abortive cases.

I. One abortive, two paralytic cases.

In a public elementary school four paralytic cases (two of these were sisters and a third had contact).

One of the others, which attended a different school, was fatal.

Two convalescent homes were attacked : one single paralytic case in one and five paralytic cases in another, consisting of two children attacked October 21 and three in female members of the staff on October 23, 24, and 26.

Its quick cessation and its failure to spread to elementary schools were epidemiological features.

Cases occurred principally in two groups and show definitely the seriousness of the disease. The attack rate here and at Sevenoaks was extremely high and makes us take a more serious view of an epidemic occurring in a young community such as proprietary schools. I presume that the panic caused in the lay mind is due chiefly to the fact that we have no active or passive immunological measures and that we do not know many of the other facts about the life-history of the virus.

ACTIVE IMMUNITY.

Brodie and Park [8] have summarized a large series of experiments in which they inoculated children with a virus inactivated with formalin. They showed that a large number of children developed antibodies in a short time.

Kolmer [9] used a vaccine inactivated with sodium ricinoleate and found that 80 to 90% of 400 children vaccinated produced antibodies comparable with those found after a natural attack of poliomyelitis.

Both authors mentioned the risks of minor local reactions, but neither mentioned constitutional upsets. Nevertheless, J. P. Leake [10], who is Medical Director of the United States Public Health Service, records 12 cases, all of whom were given vaccine and developed poliomyelitis. The paralysis usually started a few days, six to fourteen, after either the first or second dose of vaccine. Six were fatal and the remainder had paralysis. Poliomyelitis was not epidemic in any of the localities where these cases occurred, and the likelihood that all were the result of natural infection is highly

remote. Moreover, the fact that the level of the spinal cord first attacked corresponded to the extremity in which the injection was made, paralysis occurring in that or in the contralateral limb, lends further support to the ætiological role of the vaccine.

The author does not mention what methods of attenuation were used, except that he states " The two different forms of treatment to which the virus was subjected were intended to render it innocuous when thus used as a vaccine ".

Treatment

I do not propose to discuss the serum treatment of the established or the pre-paralytic cases. I think the general consensus of opinion is against its value, but I do propose to say a few words about the possibility of the prophylactic use of convalescent serum among contacts.

In 1928 H. Davide [11] reported that in a small epidemic in a scantily populated Swedish district, 73 were given prophylactic serum and 84 were not. He took particular pains that the two series should be as nearly identical as possible, all under 25 years. He had great difficulty in explaining why he wished to inject only half the family, but he was successful in doing so. 5 c.c. of serum obtained from a convalescent on the tenth day after the disappearance of the fever was given intramuscularly. One of the 73 injected and 14 of the 84 non-injected developed anterior poliomyelitis. It was certain that the one failure who was given serum was already affected at the time of inoculation.

This type of experiment was repeated on a larger scale at the Los Angeles County Hospital in 1934 [12]. Table V shows the extent of the epidemic. Prophylactic serum was given to all who elected to have it, in doses of 20 c.c. of either convalescent-pooled or normal-pooled serum, and it was recommended that this or larger doses should be repeated every two weeks. Table VI shows that those who received serum were attacked much more often than those who did not receive serum. One explanation which has been brought forward is that those who were most likely to apply for serum were subject to the greatest exposure. There was some evidence to show that those receiving serum prophylactically developed less paralysis. I think all we can say is that the question of serum prophylactically is still *sub judice*.

Nasal spraying.—Sabin and his co-workers have shown that repeated spraying of the nose in monkeys with astringent solutions protects them against poliomyelitis introduced by this route [13]. Small experiments have been carried out on human beings with far less satisfactory results, but as possibly this technique may be perfected, it is important to consider the portal of entry of the poliomyelitis virus.

It is now admitted that poliomyelitis and polio-encephalitis are the same disease. It is interesting to speculate why it is usually children over 5 who are attacked with polio-encephalitis, and children under 5 and adults who are attacked with poliomyelitis. Sir Arthur MacNalty very hesitatingly drew the inference that the older brain, more exercised than that of the younger child under the stress of modern education, is more prone to be attacked than the spinal cord [14].

I have been struck by the association of pharyngitis and polio-encephalitis, and it seems very reasonable that the virus gains entrance via the tonsillar nerves. The tonsil has a plentiful nerve supply, partly from the lesser palatine nerves, which are branches of the maxillary division of the 5th through the sphenopalatine ganglion ; partly from the glossopharyngeal nerve, i.e. the 9th. Virus tracking along these nerves would reach that part of the brain which is usually attacked in polio-encephalitis.

It is therefore reasonable to assume that astringent treatment to the nose would have no effect upon cases arising subsequent to a tonsillitis.

School Closure

I now come to the most debatable part of this problem—the policy of school closure.

We have in all fairness to inform parents when the first case of poliomyelitis occurs. We have to tell them that we have no specific treatment; that active immunity is fraught with risk; that passive immunity is of questionable value; and that the local treatment to the throat is of doubtful worth. At the same time, we can tell them that isolated cases are extremely common; that epidemics, though alarming when they do occur, are nevertheless rare. On the appearance of the first case I believe we are justified in saying that our advice is to leave children at school. If a second case arises, then parents should be immediately notified of this and given the chance of removing their children.

In the past the parents have not taken sufficient trouble to prevent their children from mixing with other children. We have no very certain evidence how many children become carriers, or indeed what proportion of abortive cases there are to paralytic cases. In these connexions it is well to remember the work of Paul and Trask, who showed that in 222 families from which a frank case of anterior poliomyelitis had come, 40% of the patients' siblings under 15 years of age developed minor illnesses contemporaneously with the appearance of anterior poliomyelitis, compared with a 10% incidence in controlled families. Twelve attempts were made to isolate the virus by inoculations in monkeys from the throats of patients with characteristic minor illnesses, and two of these were successful [15].

Dr. Lambert will shortly tell you that though there were only five cases at Wellington in the recent epidemic, there was a far larger number than this who developed it in the holidays.

I should like to make it a definite rule that if parents remove their children from school for poliomyelitis, they should quarantine them for the recognized period of fourteen days from the last contact.

Table V.—Los Angeles County Hospital Employees who Developed Poliomyelitis May 20–September 1, 1934.

			No.	No. developing poliomyelitis	%
Working in Communicable Diseases department			483	57	11·9
Working in other parts of hospital ..			3,503	57	1·3
Physicians	Living in hospital		160	16	10
	Living outside hospital ..		590	3	0·6
Nurses	Contact in C.D. dept.	Living in hospital	75	27	36·0
		Living outside hospital	277	24	8·5
	Not in C.D. dept.	Living in hospital	435	37	9·0
		Living outside hospital	297	14	5·0
	Total	Living in hospital	475	50	10·5
		Living outside hospital	609	38	6·2

Table VI.—Employees.

		No.	No. developing poliomyelitis	%
In C.D. dept.	Employees who received serum ..	228	32	14
	Employees who received no serum ..	261	25	9·7
Not in C.D. dept.	Employees who received serum ..	665	29	4·5
	Employees who received no serum ..	2,825	29	1·0
Total	Employees who received serum ..	892	61	6·8
	Employees who received no serum ..	3,094	54	1·7

REFERENCES

1 Public Health Notes, *Lancet*, 1939 (i), 176.
2 Special Report. Medical Research Council No. 227, 1938, Epidemics in Schools, p. 175.
3 Memorandum on Acute Poliomyelitis issued by Medical Officers of Schools Associations, May 1933.
4 Scott Brown, W. G., *Lancet*, 1931 (ii), 1287.

5 BUCHANAN, G. S., Office International d'Hygiene Publique, 1934, **261**, 239.
6 ROSENOW, E. C., *J. Infect. Dis.*, 1932, **30**, 377.
7 M.O.H. Annual Report, 1926, p. 88.
8 BRODIE, M., and PARK, W. H., *J.A.M.A.*, 1935, **105**, 1089.
9 KOLMER, J. A., *ibid.*, 1935, **105**, 1093.
10 LEAKE, J. P., *ibid.*, 1935, **105**, 2152.
11 DAVIDE, H., *Bull. Office internat. d'hyg. pub.*, 1928, **20**, 74.
12 KESSEL, J. F., HOYT, A. S., and FISH, R. T., *Am. J. Pub. Health*, 1934, **24**, 1215.
13 SABIN, A. B., OLITSKY, P. K., and COX, H. R., *J. Exper. Med.*, 1936, **63**, 877.
14 MACNALTY, A. S. "Epidemic Diseases of the Nervous System." London, p. 137, 1927.
15 PAUL, J. R., and TRASK, J. D., *Lancet*, 1932 (ii), 185.

Dr. G. O. Barber (Medical Officer to Felsted School): When acute anterior poliomyelitis appears in a boarding school, there are the following urgent problems to be solved at once. There may be that of (1) publicity; the speaker was unfortunate in that the particular epidemic in which his school was involved arose at the beginning of the "silly season", with the result that as a headline "Infantile Paralysis at a Public School" competed with headlines relating to the international situation. Parents were alarmed by the terrifying accounts in the newspapers, and the school authorities had to be reassuring, and at the same time avoid the accusation later of having hidden or belittled the danger.

Further, one must consider: (2) The treatment of the actual cases. (3) Any possible source of infection. (4) Who should be regarded as contacts, and what measure of segregation should be taken. (5) The question of keeping the boys together at the school, and thereby risking further spread in the closed community; or of sending them to widely scattered homes throughout the country, with the risk of widespread dissemination of the outbreak.

These, then, were the problems which arose in the recent epidemic in Essex last July. At Felsted School, four boys in the same house were affected at the same time. Actually no further cases occurred in the school. The treatment of the cases themselves presents no great difference in a boarding school from anywhere else.

With regard to the possible sources of infection, this was dealt with in an article in the *British Medical Journal* of December 3, 1938 (p. 1137). The simultaneous occurrence of the only four cases in a house with separate feeding arrangements, and the lack of subsequent spread, suggested food as a carrier, and a definite connexion was traced between the other cases in Essex, by means of fresh fruit supplied to this house only. The theory of spread which is at present accepted is that of carriers and droplet infection, but under modern conditions of rapid transport, buses, cinemas, crowding, and wide scattering, it always is easy to find a common factor between widely separated cases, but at the same time there are innumerable persons in contact with the supposed carrier who must be immune. Such a very high proportion of immunes during one summer should prevent a further outbreak next year, yet the disease makes an unfailing reappearance with the next year's fine weather, and increased consumption of fresh garden produce.

However, the orthodox view was, of course, adopted in dealing with the epidemic, and the following steps were therefore taken in accordance with the principles in the code of procedure drawn up by the Ministry of Health: "In regard to closure of residential schools the policy of advantage is in favour of not closing the schools on the appearance of poliomyelitis. If the school be closed any potential infection may be more widely distributed, not infrequently in homes containing young children."

Two circulars were sent out, the first to the parents of boys in the affected house, stating the fact of the outbreak and the general features of the epidemiology; advising the strict isolation of all boys in the house, either at Felsted, or if really adequate provision were possible at home, as giving the boy himself less chance of further infection. It was emphasized that the boy must be fetched by car, and the health

authorities in his neighbourhood informed of his being in their district. The school was prepared to keep all boys where adequate isolation could not be provided although this meant keeping them well into the summer holidays.

The second circular letter to parents of boys in unaffected houses was on the same lines, but rather more reassuring.

It is very desirable that some standard code of procedure be universally adopted by boarding schools in such outbreaks, so that a medical officer may know that he has behind him both authority and unanimity of medical opinion.

Dr. J. Lambert (Resident Medical Officer of Wellington College) gave a description of a sudden outbreak of acute poliomyelitis which developed at the extreme end of the Michaelmas Term 1938.

Five cases occurred at the College between December 15 and 22; 16 other boys developed the disease—several in a mild or abortive form—at home after leaving, within the next eleven days; one further case occurred nine days later as a contact of one of this group of cases.

On the whole the cases were reasonably mild, but one death occurred at home. The source of the infection could not definitely be traced. The cases were all confined to boys in the central block of dormitories, and no boy in any outside House, with separate dining rooms, was attacked. The incidence of other diseases during the term was not abnormal in type or degree—apart from a rather greater number of "bilious attacks".

Poliomyelitis had been epidemic in some degree in the vicinity of the College and surrounding districts during the summer holidays, and precautions were taken for the first three weeks of term in view of this—but no case had been notified in the village for ten weeks before the outbreak. This epidemic was unusual in that it occurred at a season of the year when the normal incidence curve was approaching a minimum throughout the country, and it was even more unusual in that a number of cases developed at home after the dispersal of the school—a feature which has never before occurred in any other public school outbreak. As far as is at present known there does not appear to have resulted any further spread from these home cases, except in one case in which a brother was infected. All parents were notified by circular of the occurrence of the outbreak and of its progress: three weeks' quarantine was advised. The College authorities acted in consultation with the Local Medical Officer of Health and an Inspector from the Ministry of Health in the investigation of the epidemic and the taking of all the necessary measures for dealing with the outbreak.

Dr. R. P. Gammie: An outbreak of four cases of poliomyelitis was described in a boarding school of 185 boys in East Hertfordshire. Attending the school in addition were 98 boys, coming from homes over a fairly wide area. During the autumn term of 1938 the weather was mild and there was an undue prevalence of stuffy head colds—largely afebrile. On November 13 a boy in one of the houses, who had been a victim of one of these colds, complained of stiffness in one leg. Examination revealed definite weakness of the muscles and a provisional diagnosis of poliomyelitis was made, and this was later confirmed by lumbar puncture. On November 16 a second boy in the same house developed a temperature with headache and stiffness in the neck but, although lumbar puncture confirmed a diagnosis of poliomyelitis, no paralysis was present then or subsequently. On the same day a maid in the affected house, who had gone home on November 13, was diagnosed as poliomyelitis by her home doctor, who had been informed of the association. Immediately the first case was diagnosed everyone in the affected house was completely isolated, and parents were advised—with the approval of the Ministry of Health—that they should not remove

their boys, although no obstacle was placed in their way if they wished to do so. When the two further cases developed, the onus of decision as to whether they should remove the children was placed on them, and all but two ($6\frac{1}{4}\%$) in the affected house did so, and roughly 15–20% in the rest of the school. Arrangements were made for the complete isolation of all day boys, a large number of whom continued at school in a separate building throughout.

On 23.11.38 a boy in another house developed acute polio-encephalitis, which proved fatal in thirty-six hours from the onset. This boy was in contact in a school society with Case 1 on 12.11.38 and sat next to Case 2 in the choir on 13.11.38. When the fourth case developed only 15 boys were left in the school out of a total of 214 boarders, and on the advice of the County M.O.H. the school was closed on December 5 on the expiry of the period of quarantine. Although this town is on the fringe of the area covered by the recent Essex outbreak, only one mild case in an infant under school age had been reported in the town on September 26. No cases developed amongst the day boys or in the town as a spread from the College, and no further cases were reported in boarders who had gone home. Parents were advised regarding transport and isolation at home and, in the main, co-operated loyally. It was impossible to determine the source of the outbreak. One point arose with regard to the removal of boys in the first instance, where several home doctors advised parents to leave their boys at school, as they (the doctors) had never seen a case of early poliomyelitis, and were quite certain that the school medical officer was more likely to spot an early case than they were!

Dr. F. E. Camps, of Chelmsford, was called in in consultation in each case.

Dr. Reginald Miller said he wished to deal only with the advice to be given to parents who had the misfortune to have children at infected residential schools, and that he did not approach the subject as an epidemiologist or school doctor, but as a pædiatric physician who was consulted by parents in this predicament. He thought that those in authority should be perfectly clear on the point that there was no question of giving parents "opportunities" or "permission" to remove their children from an infected school: the real position was that parents had an absolute right to remove their children without notice at any moment. He admired the letters sent by Dr. Barber for the reason that they candidly and quite truly acknowledged that in the event of further cases in the school the danger to the child would be to some extent increased by keeping it at school. This must certainly be the case where, as might happen, the disease appeared in repeated crops. This possibility no one could foretell, but should it occur, clearly the resident pupils would be subjected to renewed dangers of infection and repeated quarantines, whereas the children who were removed to their homes as soon as the epidemic nature of the disease was manifest escaped with one possibility of infection and one period of quarantine. In the case of the well to do, with a very few hours' notice, it is possible to arrange that the child brought home should be isolated from those under 25 years of age for two or three weeks. In Dr. Miller's experience it was the medical parents who were most frightened by the appearance of poliomyelitis in their children's schools; and no doubt, however carefully the lay public may be educated, the more they know of the disease the more anxious they will become. He hoped, therefore, that there would no longer be pressure put upon parents by public health or school authorities to keep their children at an infected residential school, where they could not be isolated, but at the best only segregated. In many instances schools had been disbanded on the appearance of the disease and, so far as children's physicians were aware, no harm had come of it. Poliomyelitis is a notifiable disease and, therefore, the public health authorities must know whether or not further epidemics of the disease had been set up by the disbandment of infected schools, and it is urgently necessary that they should no longer maintain silence in this matter.

Dr. H. M. Raven (Broadstairs) stated that he was less interested in the question of handling the school problem than in the question of the mode of infection, and would like to see more particular investigation of what was implied by " carriers ". The Essex epidemic was not only a school problem but a county one. The Broadstairs epidemic was not an infection of certain schools and Homes only, but cases were scattered all over the town, generally in single units in better-class houses. The army of " carriers " with droplet infection envisaged by the late Dr. James Collier was, he thought, rather fantastic, nor could the milk be entirely blamed, as was pressed by an American observer, for other schools and Homes using the same milk were not attacked. Dr. Raven could not free his mind from the probability that the infection came through fruit, most probably apples, at Broadstairs. This would account for the scattered units of infection, and there was no doubt about the swarm of flies which was very obvious at the time of the Broadstairs epidemic. He wished Dr. Barber had expanded the suggestion that the Essex epidemic might have been spread through strawberry pickers. This fruit was, at any rate, one source through which the virus may well have been carried from the nasopharynx of a picker, via flies or slugs, to the consumer of the strawberries ; of course, only the surface of certain of the top berries would be infected. This was the line on which he thought more work might well be done : the more exact details of the " carrier " problem, as regards milk, fruit, and other foods.

Dr. M. Mitman said that the control of poliomyelitis in schools could not be divorced from the problem among the general population. He showed tables comparing the relative incidence of poliomyelitis and polio-encephalitis in England and Wales and in London during the last decade ; and an analysis of the London figures in age-groups. The ratio of poliomyelitis to polio-encephalitis was 14 to 1 in children 0–1 year, 25 to 1 in children 1–5 years, and thereafter declined to 8–1 in young adults. The portal of entry of the virus was of particular interest from two aspects. If infection was invariably due to inhalation, control would be much more difficult than if ingestion was responsible. The experimental work on monkeys and the presence of the virus in the nasopharynx of patients was strong presumptive evidence that inhalation was a common mode of infection ; but the recovery of the virus from the fæces indicated that the alimentary canal might be the portal in some cases. The possibility should be considered that polio-encephalitis was more likely to follow an inhalation infection and poliomyelitis an ingestion infection. If inhalation was the invariable mode of infection, and if the spread was always neural, it was difficult to understand why the virus from the nasopharynx affected the lower spinal cord first, and later involved higher parts of the nervous system along which the virus had previously passed without apparent effect.

Dr. F. E. Camps mentioned the fact that during the Essex outbreak there appeared to be a definite association between the amount of exercise taken during the acute stage of the disease and the amount of paralysis which ensued. He described a series of cases which had occurred following an epidemic in a public school, commencing with maids who had made the beds of the boys and from them to their brothers and sisters at home and thence to a visitor to the next-door cottage who developed the disease after returning home and who had apparently infected his two small cousins who lived some distance away and with whom he had played. He suggested that there seemed to be a large number of interpretations of the definition of an abortive case ; that of Paul would seem to be the most reasonable, namely : " An acute febrile episode with vomiting, headache, and sore throat, which frequently lasts only twenty-four or thirty-six hours, but is liable to leave the child feeling below par for several days." He described some cases of this type he had seen and suggested that they were possibly one of the chief sources of infection.

Clinical Section

President—DUNCAN FITZWILLIAMS, C.M.G., F.R.C.S.

[*December* 9, 1938]

Spindle-cell Sarcoma of Scarpa's Triangle: Interinnomino-abdominal Amputation.—G. GORDON-TAYLOR, O.B.E., M.S.

Female, aged 23, married.

Tumour in upper part of left thigh for six months.

Wassermann reaction negative. No evidence of any metastases on thoracic, clinical, or X-ray examinations.

Biopsy: Very vascular tumour. Severe hæmorrhage necessitated ligature of the femoral artery.

Hind-quarter amputation, 10.7.37: Good recovery, although marked tachycardia for two weeks after operation. Well, with no recurrence eighteen months after.

The PRESIDENT in congratulating Mr. Gordon-Taylor on the success of his operation, said these hind-quarter amputations were more common now than formerly. The third patient on whom he had performed the operation died nine hours later, after having recovered from the shock, with symptoms pointing to embolism of the lung. At the autopsy an embolus was found coming from the right auricular appendix which was full of clot. He could not help thinking the blood transfusion must have had something to do with the rapid formation of such a clot.

Polycystic Disease of Liver.—G. GORDON-TAYLOR, O.B.E., M.S.

Female, aged 41.

1926: Laparotomy for doubtful abdominal tumour revealed nature of tumour—cysts in liver.

1931: Abdomen reopened, cysts aspirated, and portion of wall taken for section. Fibrous-walled cyst lined by squamous epithelium.

1938: Readmitted (now aged 53). Further enlargement of liver. Kidneys palpable but ascending pyelogram did not show appearance of polycystic kidneys.

Neurinoma of Branch of Nerve of Right Vagus.—G. GORDON-TAYLOR, O.B.E., M.S.

Male, aged 27.

Lump in neck for one year, displacing carotid vessels laterally; tonsil pushed toward mid-line of pharynx.

Biopsy of tonsil removed revealed only inflammatory tissue. Tumour thought to be a lymphosarcoma, but did not respond to deep X-ray therapy.

23.6.38 : Tumour excised and found to be a neurinoma. At the time of operation it was regarded as a gland tumour, and only on histological examination was its real nature revealed.

Three attacks of severe dyspnœa after operation. Convalescence then uneventful.

Carcinoma of the Left Lobe of the Liver.—CECIL P. G. WAKELEY, D.Sc., F.R.C.S.

Mrs. Alice F., aged 67, came under observation in May 1938, complaining of abdominal pain, flatulence, and pain across the shoulders. She had had a similar attack about a year previously. The pain began in the epigastrium and spread to the lower abdomen. The onset of the pain occurred from one to two hours after food. Bowels regular ; occasional doses of salts taken.

On examination.—Liver slightly enlarged and somewhat tender. Right kidney also palpable. X-rays showed a pouch-like diverticulum of the 2nd part of the duodenum, but nothing else abnormal.

The patient was somewhat better during the summer, but the pain returned again in November when she was admitted for investigation. She said she had lost a stone in weight during the previous six months.

On examination (November 23, 1938).—Hard craggy mass, size of a football, felt protruding under left costal margin, irregular in outline, and quite painless on pressure. Bilateral œdema of legs. Heart enlarged ; apex beat one inch outside nipple ; first mitral sound loud and short. Tachycardia and dyspnœa on effort.

The œdema was considered to be cardiac in origin and the patient was put on a salt-free diet.

Blood examination : R.B.C. 4,930,000 per c.mm. ; Hb. 80% ; C.I. 0·81. Occult blood test in fæces negative.

Per rectum nothing abnormal. *Per vaginam* nothing abnormal.

A barium meal showed a large mass in the region of the liver which extended down in front of the fundus of the stomach, displacing it backwards. The right half of the diaphragm was considerably displaced upwards. The splenic flexure appeared normal.

Since the patient has been under observation in hospital she has had no pain.

Carcinoma in Axillary Tail of Left Breast : Multiple Secondary Bone Deposits.—CECIL P. G. WAKELEY, D.Sc., F.R.C.S.

Miss H. G., aged 38, a nurse-housekeeper, first noticed pain in the lower part of her spine and in her legs. In the last four months she has lost a considerable amount of weight. When she came to hospital because of these pains, clinical examination of the spine and lower extremities revealed little. X-ray examination, however, showed multiple deposits in both femora, pelvis, lumbar vertebræ, and skull. There was also a secondary deposit in the 6th cervical vertebra which was causing a certain amount of collapse.

A very thorough examination of the patient revealed a carcinoma in the tail of the left breast with a hard secondary gland in the axilla. There was also a small adenoma in the right lobe of the thyroid. The blood-count showed a slight secondary anæmia. Routine examination of the rest of the body was negative.

The secondary deposits in the skull were most marked in the occipital region, where there was extensive destruction of the bone.

Lobectomy for Bronchiectasis, with Cure of Diaphragmatic Hernia.—J. E. H. ROBERTS, F.R.C.S.

W. V., a boy, admitted to the Brompton Hospital on 29.5.36, then aged 5 years.

History.—February 1935 : Had an attack of bronchopneumonia, from which the convalescence was not satisfactory. June 1935 : Again in hospital with a

cough, a good deal of sputum, and vomiting. X-rays showed opacity at base of left lung. Exploratory puncture made; no fluid found. July 1935: Bronchoscopy performed; pus seen coming from left lower lobe bronchus. At this time lipiodol bronchogram showed no bronchiectasis. Another skiagram, on 30.7.35, showed left chest to be completely opaque. August 1935: Swelling appeared in post-axillary line below angle of scapula and was incised. Thick pus obtained, containing pneumococci. February 1936: Readmitted to hospital with vomiting, cough, and thick, viscid sputum. X-rays showed heart drawn to left and diaphragm elevated on left side. On 29.5.36 patient transferred to Brompton Hospital.

16.6.36: Skiagram with lipiodol showed bronchiectasis of left lower lobe. At this time the sputum was not more than half an ounce. Occasional hæmoptysis. Considerable clubbing of fingers. No vomiting.

Operation (26.6.36).—Left lower lobe lobectomy. There were very firm adhesions. Owing to the difficulty of separating the lower lobe, no attempt was made to remove the lingula. The lobectomy was performed in one stage, with application of a tourniquet to the pedicle. It was found that a hernia containing omentum and a large portion of the stomach was present through an opening in the diaphragm, situated anteriorly in the muscular portion of the diaphragm to the outer side of the central tendon. The stomach and omentum were covered with thin, fibrous tissue forming a sac, though it was not certain this was a true peritoneal sac. This covering was removed, and the stomach and omentum reduced into the abdomen. The orifice was closed by a series of interrupted catgut sutures, which were further reinforced by a series of mattress sutures. Half an inch of the left phrenic nerve was removed in order to relax the diaphragm. At the end of the operation a bronchoscope was passed, pus was aspirated from the trachea and a blood transfusion was given.

The patient made a good recovery and was discharged, 5.12.36, with no cough or sputum.

Since then he has put on weight and grown. He occasionally has a slight cough. A skiagram with lipiodol taken on 3.11.36 showed the persistence of bronchiectasis in the lingula. Another skiagram taken on 23.9.38 showed that the abdominal contents remained below the high diaphragm.

Obstructed Diaphragmatic Hernia in a Child with Diaphyseal Aclasia.—J. E. H. ROBERTS, F.R.C.S.

S. P., a boy, was admitted to St. Bartholomew's Hospital on 14.3.36, then aged 7½ years.

History.—At the age of 4 he had an attack of vomiting with colicky abdominal pain. Pain in region of umbilicus, worse when standing, eased by lying down. Bowels regular. No abnormal physical signs in chest or abdomen found when examined in Out-patients Department. Recurrent attack two months later.

When aged 5 similar attack occurred and the child was admitted to St. Bartholomew's Hospital, 26.6.32.

On examination.—Percussion note grossly impaired and sense of resistance to direct percussion at left base. Multiple exostoses. 27.6.33: X-rays showed shifting of heart and mediastinum to right and opacity at left base. Screening revealed clear areas over left chest. ? pneumothorax, ? gut. Physical examination now showed percussion note hyper-resonant at left base. Barium meal revealed stomach in normal position but coils of large gut situated in left chest.

Readmitted 3.1.34: Slight attack of subacute intestinal obstruction. 14.3.36: Similar attack, vomiting more marked. Child complained of pain in the upper part of the abdomen and hypochondrium. 16.3.36: Vomiting still continued. Strong

smell of acetone. Patient doubled up with pain and dehydrated. Pulse rising, 170. 390 c.c. intravenous glucose saline administered.

16.3.36 : Laparotomy. Left paramedian incision. Stomach distended, condition relieved by stomach tube. A large part of the small intestine was found behind the stomach and appeared to be obstructed by the constriction formed by the colon entering the opening in the left dome of the diaphragm.

Post-operative : Pneumothorax left, complete. Mediastinum shifted 3 in. to right of sternum.

20.3.36 : 300 c.c. of air removed from left thorax by needle in 2nd interspace posteriorly.

16.4.36, Second operation : Thoracotomy ; intercostal incision, 8th space. Hemithorax opened. Opening in diaphragm seen just internal and anterior to the midpoint of dome. No hernial sac. The large intestine was firmly adherent to the upper surface of the diaphragm and to an exostosis which was found projecting from the inner surface of the 8th rib close to its costochondral junction. Adhesions were divided, the opening in the diaphragm defined 2 in. in diameter. After separation from the upper surface of the diaphragm the gut was easily pushed down into the abdomen. The opening in the diaphragm was closed with mattress catgut sutures. The wound was closed and air was removed from the pleural cavity by means of an artificial pneumothorax needle until a negative pressure was obtained. A blood transfusion of 200 c.c. was given.

Subsequently blood and air were aspirated on several occasions from the left hemithorax.

23.5.36 : Extreme flattening and absence of respiratory excursion of left chest. Scoliosis and cavity to the left. Breathing exercises started.

19.6.36 : Discharged well.

The child has been kept under continuous observation. He had an attack of catarrhal jaundice in March 1937, but there has been no return of the symptoms of diaphragmatic hernia. He has diaphyseal aclasia with multiple exostoses on many of the bones.

Cardio-Omentopexy.—JOHN B. HUNTER, M.C., M.Ch.

Joseph M., aged 57 years, a variety agent.

Well until March 1937 when he had pain in chest while mowing lawn. Pain severe, of sudden onset, over upper chest and down right arm. No dyspnœa. Rested four days. Pain became less, but it now radiated down both arms. In bed for one month ; pain gradually disappeared, but returned on walking or effort, and has come and gone since.

October 1937 : Another attack—severe, but less so than the previous one. Associated dyspnœa during attacks.

30.10.37 : Admitted to hospital.

Present health.—Slight indigestion.

Family health.—Mother has high blood-pressure and similar pains.

Habits.—Heavy smoker, 50-60 cigarettes, pipe, and cigars. Alcohol : Not much taken, only spirits.

Clinical examination.—Well nourished, not ill-looking. Emphysematous chest. Unable to walk more than length of ward without getting pain. Pulse 70–80. Temperature normal. Heart enlarged ; apex beat 4½ in. from mid-sternal line. Blood-pressure 125/70. Liver enlarged 2 fingerbreadths. Urine negative. Wassermann reaction negative. X-ray examination : Heart enlarged to left. Aorta unfolded.

Operation (3.12.37).—Under avertin, gas, oxygen, and ether. Osteoplastic flap of sternum. Pericardium exposed and opened. Small opening made in mid-line through pericardium and peritoneum. Omentum drawn up and sewn to ventricle. Wound closed. Patient's condition good. Blood-pressure on 20.12.37 130/70. Patient was up after four weeks.

Electrocardiogram, 19.11.37, i.e. before operation: Left ventricle preponderance. T_1, T_4 inverted, and T_4 reversed. Curves of coronary disease. 5.1.38: Left ventricle preponderance. T_1 and T_2 inverted. Lead 4 normal. 19.1.38: Same as on 5.1.38.

Discharged 22.1.38: Free from anginal pains on walking distances greater than those which previously caused pain.

Condition when seen as out-patient on 8.4.38: Satisfactory. Blood-pressure 170/120; on 27.5.38: Some pain on walking. Blood-pressure 186/110. Electrocardiogram; T_1, T_2, and T_4, inverted. Depressed S_4, T_4; on 28.10.38: Satisfactory. Pain better. Blood-pressure 174/110. Electrocardiogram: T_1 and T_4 inverted with abnormal ST intervals. Skiagram: Heart still enlarged.

Angina Pectoris treated by Cardio-Pneumonopexy. — LAURENCE O'SHAUGHNESSY, F.R.C.S.

Patient, male, aged 45, a lamplighter. Angina pectoris for eight months. No work since onset. Referred to the L.C.C. Cardio-vascular Clinic at Lambeth Hospital by Dr. Russell Brain and admitted on 25.1.38. He had previously been operated on for a perforated peptic ulcer. No family history of angina.

On examination.—Oral sepsis. Heart showed a left ventricular hypertrophy and loud harsh systolic murmur typical of aortic stenosis. Blood-pressure 115/90. Urine and kidney function tests normal. Blood-urea 28 mgm. per 100 c.c. Wassermann reaction negative.

After dental extractions cardio-pneumonopexy was performed on 11.2.38. Recovery was uneventful, and the patient was discharged for convalescence on April 28.

He has had no angina since discharge from hospital. Now cycles for an hour a day, and digs in his garden. Blood-pressure is now 124/74.

Malignant Hypertension.—A. DICKSON WRIGHT, M.S.

Mrs. E. W., aged 28, a rather stout woman, coming of a healthy family with no history of vascular disease. Her first pregnancy occurred when she was 18 and was terminated at the sixth month on account of toxæmia with albuminuria and hypertension. Five years later a second pregnancy had a similar outcome, and with a third pregnancy, eighteen months ago, the symptoms were so severe that the patient was sterilized after the termination of the pregnancy, at the third month.

The patient continued to be ill; dizziness, lack of energy, and very severe headaches being the main complaints. She also noticed that her sight was deteriorating and there was pain in the eyes after reading. Systolic blood-pressure during this period was frequently as high as 300.

After admission to hospital the pressure while resting in bed was usually 240/160; while she was asleep it would drop to 180 systolic. After administration of a full dose of pentothal sodium the pressure fell to 120 systolic. The hands immersed in cold water produced a rapid and long-sustained rise of pressure. Urine: A small amount of albumin and an occasional hyaline cast. Blood-urea 28 mgm. per 100 c.c. The optic fundi showed the marks of many hæmorrhages.

It was felt that this was a labile type of hyperpiesis and operation was performed in two stages, with a fortnightly interval. On each side the first two lumbar ganglia and all the splanchnic nerves were excised and half the suprarenal gland removed.

After the first operation the blood-pressure varied between 180 and 150; after the second it fell to 120. Some heart failure occurred about a month after the second operation and there was a small cerebral embolism, from which she recovered, and also saphenous phlebitis in the left leg.

Present condition.—The pressure keeps about 150. The patient is able to do house work, and is quite free from her previously very troublesome subjective symptoms.

Case for Diagnosis. Pneumonitis: ? Syphilitic.—J. L. LIVINGSTONE, M.D.

W. P., male, aged 61. Porter.

Complains of cough with several ounces of sputum daily, and pain in the chest.

Family history.—Nothing relevant.

Previous diseases.—Smallpox in infancy, and gout eight months ago.

History of present condition.—One year ago had "flu" with bronchitis which was followed by pleurisy. Away from work for five months; pain present intermittently until now. Returned to work for a few weeks but had to give up again and has now been off for five months. Cough has been troublesome the whole time and at the onset the sputum smelt foul. He has lost a stone in weight in the last three months. He has never coughed up blood.

On examination.—Emaciated. Fingers clubbed. Heberden's nodes present. Trachea displaced to right; both breasts palpable; a gland felt in each axilla.

Percussion: Left chest normal. Right chest impaired below 4th rib in front and in axilla. Also impaired behind below 7th thoracic spine. Much impaired near the angle of the right scapula.

Auscultation: Left lung: Occasional rhonchi. Right lung: Diminished air entry in front at the apex; absent air entry in front over the dull area. Behind, the air entry is diminished at the apex and absent in the axilla. There is loud bronchial breathing posteriorly at the level of about the 10th rib. Râles and rhonchi heard all over.

Investigations.—Sputum: No T.B. No neoplastic cells seen. Predominant organisms—non-hæmolytic streptococci.

Wassermann reaction positive.

Blood sedimentation rate: 66 mm. per hour (Westergren).

Blood-count: R.B.C. 5,000,000; Hb. 80%; C.I. 0·8; W.B.C. 7,600 (polys. 70%, lymphos. 23%; eosinos. 6%; basos. 1%).

Bronchoscopy showed scabbard-like deformity of right descending bronchus. Section showed only adenoid tissue. Treated diagnostically with pot. iodide (gr. 20 t.d.s.) and hydrarg. perchlor. (♏ xv of liq.) for three weeks. Sputum has decreased from 5 oz. to 2 oz. per day. Weight has gone up from 7 st. 10 lb. to 8 st. 2 lb. 4 oz. Pyrexia up to 99° persists.

Skiagrams.—18.10.38: Mediastinum displaced to the right. Right lung showed opacity in middle zone posteriorly and at base anteriorly. 23.11.38: No decrease in shadow. 25.11.38: After bronchography. The eparterial bronchus and its branches showed evidence of compression from without. The branches of the middle and lower bronchi showed evidence of cylindrical and saccular dilatation.

Paroxysmal Tachycardia in Two Children.—BERNARD SCHLESINGER, F.R.C.P., and H. L. ELLIS, M.R.C.S., L.R.C.P.

I.—E. P., female, aged 9½ years.

Original attack began in December 1937 and lasted a considerable time (?) in Rye Hospital. The patient first came under our care at the Hospital for Sick Children three days after another attack had been in progress, which had begun with epigastric pain, nausea, vomiting, &c. No history of rheumatism; scarlet fever 1933.

During attack the child lay very quiet, looked ill, and showed evidence of some cardiac failure. Blood-pressure 85/45. Blood sedimentation rate normal throughout.

Treatment.—Quinidine was given, and after a total of 20 gr., on the fifth day, regular rhythm was restored. Heart failure rapidly disappeared, and exercise tolerance was regained in a relatively short time. Patient is at present taking 1 gr. quinidine twice a day.

It is difficult to say whether or no the attack was curtailed by the quinidine therapy.

II.—M. L., female, aged 8 years.

History of attacks of tachycardia lasting from two to six days. These began in November 1937 and have continued at monthly intervals. During attack the patient becomes ashen-grey in colour with some cyanosis of the lips, and complains of palpitations. There is no history of rheumatic fever, but the first attack seemed to coincide with an epidemic of scarlet fever in the house, not however directly affecting the child. Two attacks have been witnessed since she has been in hospital; some cardiac failure was noted, from which she rapidly recovered with the cessation of each attack.

As the first attack subsided without any treatment in three days, the effect of digitalis and quinidine with which the second attack was treated loses significance. One of the interesting features is the regular periodicity and short duration of the paroxysmal tachycardia.

In both cases there are electrocardiographic changes immediately after the attack, pointing to the myocardial disturbance.

Aneurysm of the Abdominal Aorta.—HAROLD EDWARDS, M.S., and EMLYN E. LEWIS, F.R.C.S.

Man, aged 71. For last fifteen months has complained of thumping in the abdomen and fullness after meals. Vomit occasionally. Thumping most marked in the left iliac fossa. No pain.

X-ray examination negative. Wassermann reaction negative. Central nervous system: Nothing abnormal. Blood-pressure 148/120, equal in both arms and both femorals. Arteries thickened to palpation; do not show up on X-ray screen. Skiagram of chest shows some general dilatation of the heart, more particularly the left ventricle. No apparent enlargement of the upper thoracic aorta.

Tumour in the abdomen extending from the epigastrium to below the umbilicus. Movable in lateral but not in vertical plane. Tumour is pulsatile and expansile. Firm pressure over the tumour causes it to become smaller and a systolic murmur can be heard over it. It has increased rapidly in size during the last two months.

Melorheostosis and Gummatous Ulcers.—R. HODGSON BOGGON, M.S., F.R.C.S.

Patient, male, aged 30, complaining of ulcers of the right leg and a painful right ankle.

History.—When aged 12 he sustained a fracture of the "right foot". He was treated in splints for seven weeks and the result was good. He entered the Police Force in 1929. Eighteen months ago he noticed a swelling of the outer side of the right ankle and an aching pain in that joint after use. The swelling increased for one year, since when it has remained stationary. He has had more pain recently. Five weeks before admission two ulcers formed on the outer side of the right leg and have enlarged since. He was admitted to St. Thomas's Hospital on 10.11.38.

Condition on admission.—An apparently healthy man. There were two ulcers on the lower and outer part of the right leg, over the lower third of the fibula. The

ulcers were both about 1½ in. in diameter and had punched-out edges with sloughy bases. They were not attached to the deep structures. The region of the right ankle appeared diffusely swollen, especially over the outer side. All movements of the ankle-joint were considerably limited but not painful. Several firm, painless nodules could be felt in the subcutaneous tissue of the right leg and thigh. The tibia felt diffusely thickened at its lower end as also did the bones of the foot. The rest of the limb appeared normal.

Investigations.—X-rays were reported as showing melorheostosis of the right side of the pelvis, the right tibia and fibula, and the bones of the right foot.

Wassermann reaction ++. Kahn reaction +++.

Treatment.—Potassium iodide gr. xxv t.d.s. by mouth. The ulcers have been dressed with glycerine, alum, and zinc lotion.

Progress.—The ulcers are healing rapidly. The condition of the ankles and bones is as before.

Dr. F. PARKES WEBER said he had been interested in melorheostosis ever since the condition was first described in France. He thought the abnormality was always present, or at least potentially present, at birth, though some other condition or accident might first lead to its recognition long afterwards. As there was never any familial history, it was probably never potentially present in the fertilized ovum, but, like a large class of congenital developmental abnormalities, it seemed to be produced by the action of some unknown agent or agents during early intra-uterine life, when the *Anlagen* of the limbs were already differentiated. He (Dr. Weber) wished to draw a kind of analogy with the whole class of linear dermatoses, especially those well recognized as congenital, namely the " nævi in stripes ". In fact, he regarded melorheostosis as an osseous analogue of cutaneous and subcutaneous nævi in stripes, an analogue, for instance, of the condition known as " ichthyosis hystrix ", bands of which (usually more or less broken into islands or segments) might reach from the buttock to the ankle, or even to the toes.

What was the agent which, acting on the fœtus within the mother's body, produced the stripes of ichthyosis hystrix and the bands of melorheostosis ? He scarcely thought that cosmic rays could be incriminated, but it was much more plausible to suggest them as a cause of ichthyosis hystrix, &c., than of first cases of mutational (hereditary) diseases, such as hæmophilia. The latter suggestion had indeed actually been made.

In the present case the line of subcutaneous nodules down the affected lower limb was of great interest, as these nodules might help to confirm the classification of melorheostosis (recognition of the nature of a disease or abnormality by the study of its associates). Perhaps some day one might meet with a case of melorheostosis associated with an actual linear dermatosis of congenital origin.

Aneurysm of the Popliteal Artery: Investigation by Arteriography. Cure by Hunterian Ligature.—R. C. BROCK, M.S.

G. C. S., aged 54, was shot through the left calf by a rifle bullet in August 1917, the bullet damaging the neck of the fibula *en route*. He felt no ill-effects until twelve months ago, when a swelling appeared in the calf and the leg became very painful after walking.

In August 1938 he attended Guy's Hospital and examination revealed an aneurysm the size of a small orange, situated high in the left calf. The circumference of the leg at this point was 13½ in., that of the right leg being 12 in. The pulse in the dorsalis pedis artery could be felt.

He was admitted into Queen Mary's Hospital, Roehampton, and I am indebted to the Director-General of the Ministry of Pensions Medical Service for permission to make this report.

A radiograph (fig. 1) showed calcification in an aneurysmal sac and signs of old injury to the neck of the fibula. On clinical grounds it was uncertain whether the

aneurysm was situated on the popliteal artery itself or in connexion with its posterior tibial continuation. Accordingly arteriography was performed after the manner described by Mr. Duncan Fitzwilliams before this Section in [December 1937 (*Proceedings*, 1937, **31**, 301).

The superficial femoral artery was exposed under local anæsthesia and the patient was then transferred to the X-ray department. Uroselectan was injected into the artery through a fine hypodermic needle, a radiograph being taken after about 8 c.c. had been injected (fig. 2). The patient was then quickly turned with the leg in the lateral position, and after 3–4 c.c. more of uroselectan had been injected a second film was exposed (fig. 3). The exposure had to be made after injection of only a small amount because the patient was complaining of severe cramp-like pain in the left leg

FIG. 1.

and foot and, moreover, was trembling so violently that I was afraid to inject more uroselectan lest it entered the wall of the artery and caused sloughing. The effect of this tremor can be seen in the movement, which has unfortunately spoilt the sharpness of detail in fig. 3. It was clearly a mistake to perform the actual injection under local anæsthesia, and in future I would precede it by nitrous oxide or evipan.

The information given by the arteriograms is, however, quite definite. The aneurysm is situated on the popliteal artery itself, beginning about 2·5 cm. above its termination and extending to within 0·5 cm. of the point of bifurcation. In

addition a free collateral circulation is demonstrated although the lumen of all the arteries, major and minor, is diminished by spasm. The main vessel itself is otherwise quite normal, in contrast to the appearances of irregular dilatation and varicosity shown in Mr. Fitzwilliams' two cases in which the aneurysm did not follow direct trauma.

FIG. 2.

FIG. 3.

A classical Hunterian ligation was performed and has led to apparent cure. The aneurysmal sac is quite free from any pulsation and has shrunk considerably in size, so that it can only just be felt on careful palpation of the calf. The leg now measures 13 in. in circumference. There has been no evidence at all of any circulatory disturbance in the leg or foot. No distal pulse can as yet be felt.

THE PRESIDENT said he was glad to see the method of injecting uroselectan had been adopted in the case of this aneurysm. He thought it should be used in every case of aneurysm of the limbs before ligaturing the vessel, so as to gain accurate information as to the patency of the collateral circulation. It would be remembered Prof. Pannett (*Proceedings*, 1938, 31, 301) had at his request injected a case of popliteal aneurysm but had ligated the artery without waiting for the photographs which revealed a very inadequate collateral circulation, and the limb had to be amputated almost immediately.

Unilateral Exophthalmic Ophthalmoplegia.—L. P. E. LAURENT, M.D.

T. C., a painter aged 61, has noticed diplopia and proptosis of the left eye for the past three months. He has lost a stone in weight during the past year, but has no other complaint.

On examination.—Obvious evidence of recent loss of weight. Protrusion of left eye, but no lid retraction. Upward movements of left eye and convergence lost.

Skiagram of skull shows no abnormality. No part of the thyroid gland is palpable, but there is the following evidence of thyrotoxicosis: A resting pulse-rate of 100, slight tremor of the fingers, loss of weight, and a rather high pulse-pressure (blood-pressure 148/70). The fundus oculi, the visual acuity, and the visual fields are normal.

Slight puffiness of the eyelids in the affected eye is in keeping with Russell Brain's observations in similar cases. The right eye is normal.

DR. PARKES WEBER said he had been interested in the question: Why the exophthalmus from thyrotoxicosis was not very rarely unilateral. He had supposed the true explanation to be that the "soil" was not quite the same in the two halves of the body and that in consequence one eye was more resistant towards the excess of thyroidal hormone (in thyrotoxicosis cases) than the other eye. Similarly, in rare cases of acromegaly certain symptoms might be less marked or even absent on one side of the body, presumably because the hormone produced by the eosinophilic pituitary adenoma was more efficiently resisted on one side of the body than on the other (*cf.* F. P. Weber and F. R. B. Atkinson, *Brit. Journ. Derm. and Syph.*, 1928, 40, 454).

Acute Suppurative Pericarditis.—R. LAIRD, F.R.C.S.Ed.

Boy, aged 11 years.

9.10.37: Admitted to St. Mary Abbots Hospital complaining of severe pain in the left upper arm. The condition was diagnosed as acute osteomyelitis of the upper end of the humerus. The bone was guttered and a considerable amount of pus evacuated. The temperature did not subside satisfactorily after the operation, and on 17.10.37 præcordial pain and a pericardial rub were present. On the following day an immuno-transfusion of 200 c.c. of blood was given, the donor being a house surgeon, who had recovered from a *Staphylococcus aureus* osteomyelitis of the patella and suppurative arthritis of the knee. On 20.10.37 the pericardium was tapped and $5\frac{3}{4}$ oz. of turbulent yellow fluid withdrawn. This fluid yielded a growth of *Staphylococcus aureus*, as did the pus from the bone. Skiagrams taken at this time showed a very distended heart shadow. Acute suppurative pericarditis was diagnosed and Mr. Tudor Edwards (under local anæsthetic) opened the pericardium after resecting the 3rd and 4th costal cartilages. The edges of the parietal pericardium were sutured to the thoracic wall.

The child's pulse, which was very irregular before operation, improved considerably, and at the end of the operation was quite regular.

26.10.37: Left-sided pleural effusion present. This fluid was quite clear in character and $\frac{1}{2}$ to 1 pint was aspirated every other day.

8.11.37: $\frac{1}{2}$ oz. of thin fluid removed from right pleural cavity. Aspiration of each side of the chest was carried out on alternate days. Soon over a pint of fluid was being removed every other day from the right side of the chest. To prevent this repeated aspiration and to thicken the fluid an intercostal tube was inserted into the

right pleural cavity on 2.12.37. This had the desired effect and the effusion diminished in amount. Rib resection was performed at a later date. The left-sided effusion completely subsided with aspiration.

10.3.38 : The child was transferred to Queen Mary's Hospital, Carshalton, for a period of convalescence. When seen recently his general condition was excellent. X-rays show normal heart shadow.

Dwarfism Resulting from Chronic Regional Enteritis. — NORMAN C. TANNER, F.R.C.S. (by permission of Sir FREDERICK MENZIES).

S. R., male, Jewish, aged 18½ years, admitted to Highgate (L.C.C.) Hospital March 4, 1938.

History.—Good health and normal physical development until 1933, when he began to have attacks of abdominal pain, and was constantly fatigued.

January 1935 : Admitted to hospital. A mass was found in the right iliac fossa.

Operation (February 1935).—Laparotomy. Report on portion of mass removed : " Fibrous chronic pyogenic granulation tissue in adipose tissue. No evidence of neoplasm." The wound healed, but the listlessness continued, the pain became " unbearable " and the patient lost weight and his abdomen became distended.

April 1936 : Readmitted same hospital. Abscess in right iliac fossa incised ; watery fæces began to discharge from the wound. Afterwards defæcation gradually ceased, until there was only a monthly evacuation of a little white material. Unavailing attempts were made to close the fistula by " plugging ". In December 1936 patient was sent, with a diagnosis of peritoneal tuberculosis, to St. Luke's Hospital, Lowestoft, where he remained, with multiple fistulæ discharging fæces, until March 1938, when he was transferred to Highgate Hospital.

Condition on admission.—Appearance resembled that of a boy aged 14 or 15. Height 4 ft. 7 in. ; weight 4 st. 11 lb. No beard ; says that his two elder brothers did not shave until after the age of 19. Pubic hair scanty, but considerable local dermatitis due to the fæcal discharge. Genitalia apparently normal. Voice rather high in pitch. Intelligence and mental outlook normal.

Abdominal examination : Right paramedian scar with two fistulæ in its length ; scars of three other fistulæ, and dense " wooden " induration in right iliac fossa. On rectal examination, some induration was felt high up anteriorly.

Family history.—Three brothers, aged 11, 22, and 28, and one sister, aged 24, all of normal height.

Investigations.—Blood : R.B.C. 5,050,000 per c.mm. ; Hb. 76% ; W.B.C. 20,500 (polys. 85% ; lymphos. 12% ; monos. 3%). Sedimentation rate 26 mm. in one hour. Wassermann and Kahn reactions both negative.

Serum : No agglutination with *B. typhosus*, *B. paratyphosus* B, *B. aertrycke*, *B. enteritidis* Gaertner, *B. dysenteriæ* Sonne, or *B. abortus*.

Fæces from fistulæ : Numerous pus cells present. No tubercle bacilli seen. No pathogenic coliform bacilli isolated.

X-ray examination (Dr. Francis Rayner) : (1) Barium meal : Marked dilatation of coils of terminal ileum, beyond which the intestine shows an irregular contour, with alternating lengths of dilatation and contraction ; beyond this again the meal is seen to pass through a fistulous track to the skin, none entering the cæcum. (2) Barium enema : The colon fills normally. A few centimetres of ileum are outlined and then end in a fine narrow track. (3) After injection of barium emulsion into the sinus : This shows a constant deformity of a coil of distal ileum, corresponding in form and shape with that seen after the opaque meal. Some of the emulsion enters the ileum adjacent to the ileocæcal valve by way of another fistulous track. Again one segment of ileum fails to show an outline. (4) Elbow joints : Slight general osteoporosis ; the lower humeral, the upper radial, and ulnar epiphyses are not yet united with the shaft. (5) Skull : normal outline of pituitary fossa.

Operation (April 4, 1938).—Left paramedian incision. Small bowel examined from duodeno-jejunal flexure ; found normal as far as lower ileum, which disappeared into a dense adherent mass in the right iliac fossa. Lower ileum divided ; proximal end united to transverse colon, end-to-side, and distal end closed.

Following this, the induration in the fossa greatly diminished, and the slight distension disappeared. Discharge was fæcal for short time after the operation, then purulent ; six weeks later about 5 oz. clear fluid were discharged every twenty-four hours.

Operation (May 23, 1938).—Right abdominal incision through undifferentiated fibrous tissue—normal planes of abdominal wall being unrecognizable. Dense adhesions between ileum and anterior abdominal wall were separated. Adhesions were also found between loops of ileum and between ileum and cæcum. Bowel resected, from the site of previous division of the ileum, to the junction of the right and middle thirds of the transverse colon. Wound was closed with drainage and a blood transfusion was given.

Since then improvement has been marked. The wound has healed completely. Subsequent height and weight measurements :—

	Ft. in.	st. lb.
25.6.38	4 $7\frac{5}{8}$	4 $11\frac{3}{4}$
31.8.38	4 $8\frac{1}{4}$	6 6
17.11.38	4 $9\frac{3}{8}$	6 2
(Postscript) 25. 1.39	4 $10\frac{1}{8}$	

Patient is now working and feels well. Has a bowel action twice or thrice daily ; stools usually well formed, occasionally loose. Is encouraged not to restrict his diet.

Pathological report (Dr. W. G. Barnard) : The specimen includes the terminal 2 ft. of ileum, cæcum and 10 in. of ascending colon. The peritoneal surface of the ileum is indurated and fibrous with numerous areas of hæmorrhage and fibrous tags. The wall of the ileum is greatly thickened and hypertrophied, in places producing stenosis of the lumen, the terminal 6 in. of which is completely obliterated.

Histological examination : Active chronic inflammation of ileum with hypertrophy of muscularis and focal membranous inflammation of mucosa (Crohn's disease).

Summary.—This is a case of chronic regional enteritis, which has caused marked physical underdevelopment, probably as a result of intestinal malabsorption.

I am in some doubt as to whether the case should be considered as one of dwarfism or infantilism. There is possibly some gonadal underdevelopment, and the secondary sexual characters have not yet completely appeared.

Of interest in this case is the complete obliteration of the lumen of the terminal six inches of diseased bowel, a complication I have not seen described in regional enteritis.

Two cases of retarded growth in patients both aged 16, suffering from chronic regional enteritis have been recorded, the one by Professor I. Snapper, J. Groen and A. Foyer, and the other by A. H. Logan and R. W. Brown. The nutrition of both of these cases was markedly improved after short-circuiting operations.

BIBLIOGRAPHY

SNAPPER, I., GROEN, J., and FOYER, A. Observations sur l'ileite régionale. *Proceedings of Second International Congress of Gastro-enterology*, Brussels, 1937, p. 935.

LOGAN, A. H., and BROWN, R. W., *Proceedings of the Staff Meetings of the Mayo Clinic*, 1938, **13**, p. 335.

Unilateral Exophthalmos for Diagnosis.—C. A. CLARKE, M.D., and J. G. JAMIESON COGHILL, M.B.

G. G. L., male, aged 29. Solicitor.

Family history.—Nothing relevant.

Previous illnesses.—Occasional twinges of rheumatism in shoulders. Varicose vein, injected 1935.

History of present condition.—In January 1936 he noticed that his left eye wa becoming prominent. No pain or other symptoms. After four weeks the eye reache its maximum prominence and the condition has remained stationary since. March 1936 admitted to St. Bartholomew's Hospital where the findings were as follows :— Diplopia when looking upwards and outwards. Fundi normal. No tremor of th outstretched hand. Heart and lungs normal. Blood pressure 140/70. Thyroid gland apparently normal. Visual fields normal. Wassermann reaction negative. X-ray of the skull normal. Basal metabolic rate 41%. Sinuses normal. X-ray of the chest disclosed an unusually small aorta only.

He was put on Lugol's iodine for six weeks. This (to him) made no difference.

Since June 1936 he has been perfectly well but the prominence in the eye has persisted unchanged.

On examination.—Height 6 ft. ½ in. Weight 10 st. 10 lb. Well-marked unilateral left-sided exophthalmos. Thyroid not enlarged. No evidence of thyrotoxicosis. Pulse 82. Blood-pressure 126/82. Vision normal. Fundi normal. Pupils react to light but reaction is not well held, particularly in right eye. Rest of central nervous system normal. There is a small lipoma on the right forearm.

Inferior Vena Cava Obstruction : for Diagnosis. — Sir MAURICE CASSIDY, K.C.V.O., M.D., and E. M. BUZZARD, M.R.C.P.

W. D., aged 38. Police constable.

Symptoms.—" Bursting feeling in ears " for two months ; dyspnœa on exertion ; hæmoptysis.

Past history.—Rheumatic fever as a child. Pneumonia four years ago. Thrombosis of external popliteal vein three years ago.

History of present illness.—Two months ago patient noticed intermittent swelling of the face and neck, aggravated by bending down and accompanied by a bursting feeling in the ears. One hæmoptysis occurred, of about ¼ pint. Dyspnœa on exertion. Symptoms vary ; at times he is quite fit.

On examination.—Marked superior vena cava obstruction. Heart normal in size. No murmurs. Blood-pressure : Right 112/65. Left 112/65. Chest emphysematous. No glandular enlargement. Liver and spleen not palpable.

Investigations.—Wassermann reaction negative. Skiagram of lungs normal. No evidence of mediastinal enlargement. Oblique skiagram of chest normal. Screening mediastinum : no visible cause for obstruction. Barium swallow normal. Blood sedimentation rate : 17 mm. in one hour.

Section of Laryngology

President—C. A. Scott Ridout, M.S.

[*December* 2, 1938]

DISCUSSION ON FUNCTIONAL DISORDERS OF THE VOICE

Douglas Guthrie: *The laryngological aspect.*—Vocal function is rarely investigated. Mirror in hand, the laryngologist, viewing an apparently normal larynx, diagnoses a "functional disorder" without being aware of its exact nature.

A number of books on the singing voice have been written by singers themselves, but words of indefinite meaning are often used and the reader is presumed to possess a fair acquaintance with music. The work of the scientist, on the other hand, is confusing to the singer who may have an inadequate knowledge of physiology. Each should contribute to the subject in his own way, for only by such collaboration can a clear picture be drawn. The repairer of musical instruments must have some idea of music; the musician must know something of the construction of his instrument. So it is with the instrument we call the vocal mechanism.

Let me try to give a brief account first of the vocal apparatus and its function, and then of the physics of vocalization, and finally of the disorders of vocal function.

(1) *The three parts of the vocal machine.*—The larynx is only a part of the vocal mechanism. The organs concerned in breathing, articulation, and resonance, must also receive consideration.

For the production of voice a strong, controlled, and prolonged act of expiration is necessary. This is secured by reinforcing the upward passage of the diaphragm and the downward movement of the ribs by contraction of the abdominal muscles, a method practised by the singer until it becomes almost a reflex act (so-called abdominal press). Some singers and speakers believe that the lower ribs should be maintained in a raised attitude (rib reserve).

The laryngeal contribution must next be considered. The entire larynx is maintained in certain attitudes during vocalization. The vocal cords, with the thyro-arytenoid muscles as their foundation, are adjusted by the aid of all the laryngeal muscles, in their shape, bulk, and consistency. The actual vibration of the cords is not a muscular effort but an aerodynamic phenomenon, and it cannot be studied by laryngoscopy nor cinematography. Only by the stroboscope can the vibratory movement be followed, as a slow-motion picture. When the number of interruptions of the source of light are, say, 127 per second and a note corresponding to a pitch of 128 vibrations is produced by the larynx, then the cords are seen to move at a rate of one vibration per second. It is strange that an instrument which furnishes such valuable information has not yet come into general use in laryngology.

The third component of the vocal mechanism is the resonator. The two resonating chambers, buccal and pharyngeal, are capable of wide variations of shape and size. The first-named is also the apparatus of articulation. Coupled to the larynx, the resonators act as a sort of mobile loud-speaker horn; without resonance, the laryngeal note is weak and indefinite, as has been shown by experiment and by observation in cases of cut throat.

(2) *Some physical considerations.*—Certain facts regarding the development of voice, the range of voice, and the so-called registers, are worthy of note. The cry of the infant corresponds to 435 cycles and the range gradually extends, but remains

very limited before the age of puberty. At that time the vocal cords lengthen and the male voice undergoes the remarkable alteration known as the " break " or mutation, and the vocal pitch is lowered to that of the adult voice. In girls the vocal change of puberty is much less apparent. A redness and slight swelling of the vocal processes is common at this time and may lead to an erroneous diagnosis of laryngitis, especially if the changes of voice take some months to become complete. In cases of incomplete mutation, a high-pitched voice may persist throughout life, although it is easily treated by gentle backward pressure on the thyroid cartilage during the production of a low note and by suitable humming exercises. Cases accompanied by arrest of sex development are less favourable but may yield to hormone treatment.

After puberty the voice may be classified according to its compass, as bass, baritone, and tenor in men, or as soprano, mezzo, and alto, in women. In southern countries there is a preponderance of low female (alto) and high male (tenor) voices, while Orientals tend to have high-pitched voices. An individual voice seldom extends over more than $2\frac{1}{2}$ octaves and the pitch used in speaking lies at the lower part of the singing range. Incorrect classification (for example, a baritone who believes that he is a tenor) is one of the commonest causes of vocal failure.

The method by which a note is initiated, in other words the mode of attack, is of great importance in vocal hygiene. All teachers are agreed in advising the crescendo method of " swelling on a note " and in condemning " glottal shock ".

The existence and number of the " registers " have provoked much discussion. As a rule the chest, middle, and head registers, are named according to the subjective sensation of the singer, although such names do not imply that the voice is produced at such levels. There is a change of vocal quality as the singer passes from one register to another. The position of the larynx may alter and there are changes of the vocal cords in form and tension which may be revealed by stroboscopic examination.

(3) *Treatment of vocal dysfunction.*—It is not easy to classify the functional disorders of voice. The patient may complain of weakness of voice, of a tendency to " crack " at certain pitches, of recurrent hoarseness, or of a great variety of subjective sensations such as dryness, burning, tightness, pressure, &c., all of which are increased by use of the voice.

After hearing the patient's story, which may be lengthy, the laryngologist must make a careful examination, but in doing so he must remember that a dry mucosa, lymphoid nodules, or dilated vessels, may be the result and not the cause of the vocal trouble. He may discover a deviated septum or enlarged tonsils, but as a rule these structures have been efficiently removed by some colleague previously consulted. It is possible to sing " Lohengrin " when suffering from tonsillitis but not when suffering from *phonasthenia*, which is a useful generic term for the disorders under consideration. Functional examination must not be forgotten. The singer should be asked to sing, and the vocal range, the mode of attack, and the method of breathing, should be noted.

The psychological factor enters into every case. All good singers are " temperamental " and are thus liable to suffer from occupational neuroses. Anxiety or fear may play a leading part, and if the patient be reassured that his fears are groundless, he will rapidly regain his vocal equilibrium. Without any profound knowledge of psychical treatment the laryngologist may do much for his patient by simple suggestion, and he is quite justified in seeking to discover the environmental error which may be the cause of all the trouble.

Orthophonic or re-educative treatment lies more within the sphere of the teacher of singing than that of the laryngologist, but the latter may often be of service in regulating such treatment and in noting its results. Some continental laryngologists make use of the harmonic vibrator, an instrument which transmits to an applicator held against the front of the larynx audible vibrations which may be felt as well as heard. With the apparatus in action it is easy for the patient to sing a note of

corresponding pitch, indeed it is unpleasant and even painful to sing out of tune with the vibrator.

Local treatment, so often empiric or symptomatic, must be regarded as secondary in importance to the above-mentioned method of correcting errors of function.

While treatment should take into consideration any general hygienic measures which may seem necessary, and such advice regarding fresh air, food and exercise as the case demands, it is best to avoid direct treatment of the larynx. This, however, is a counsel of perfection, as local treatment is usually uppermost in the minds of patient and laryngologist alike. Physical therapy in two forms may promote recovery: first, the local application of a cold compress, and second, massage of the neck in the region of the larynx.

As for medicinal treatment, any solution used should be weak and soothing. Spraying is better than painting. Every singer has his favourite spray which is usually too strong or may be employed too frequently. Menthol or one of the essential oils forms the active ingredient, and the solvent should be the thin variety of liquid paraffin rather than the B.P. preparation. The laryngologist may be obliged to use a weak cocaine solution in order to enable a singer to fulfil his engagement, but this should be regarded as an emergency measure. The application of a weak aqueous alkaline solution to the nose and nasopharynx by a coarse spray may give greater relief than a spray applied to the larynx. Nevertheless, in all cases local treatment must be regarded as an adjuvant and a temporary palliative. The cause of the vocal failure or weakness must be sought and remedied.

Augustus Milner: *The singer's point of view.*—The purpose of this paper is to present briefly a singer's view of some vocal disorders, with their causes and their management by re-education. As a lack of technique is so important a factor in vocal disorders, a short description of the technique used by me in teaching singing might be helpful in indicating a line of treatment for those who are consulted by singers suffering from functional vocal troubles.

Environment factors in singing are numerous and varied. I shall mention only a few. The singing of very young children can be delightful, and the first interference with this may be encountered when the child enters school. The prevalent idea that, in group singing, all voices should conform to one pattern, is destructive to the voice—the lovely fresh, individual quality becoming replaced by a hollow, breathy, unnatural sound. This is intensified in part singing when a child is given the low part, without a range test, merely because he can keep in tune.

As a rule untrained voices, both child and adult, are higher than they at first appear to be. A rapid increase of high range may take place under rational management. Forcing the voice on low notes is unwise.

Language.—I do not agree with the view that certain languages have a bad effect on voice production. I can only speak from personal experience of European languages. It is true that different languages vary in sonority depending on the proportion and type of vowel and consonant sounds used in each. For this reason a voice may appear to have greater resonance in one language than in another. But that does not imply any change of mechanism. Nearly all the great singers of whatever nationality produce the voice in the same way.

Sensation in singing.—A singer is aware of both hearing and feeling. There may be two or even three kinds of sensation associated with voice production: (1) The first and most important feeling is a restful sensation of freedom in the pharynx. Intense conscious listening to one's own voice is not advisable.

(2) The second feeling is called, in singers' terminology, the " resonance " feeling. Good voice production may be accompanied by a sensation of vibration in the head, and when the singer is aware of this sensation he feels that he is singing with " good resonance ". Correct production is possible without this feeling, as Garcia proved,

when four of his great pupils sang high C in succession ; one felt it in the back of the head, one on the top, one in the face, and the fourth did not feel it at all, and all four were right.

(3) Those associated with speech sounds, due to the movement of the lips, tongue, jaw, and soft palate.

Classification of voices.—It is well to remember that quality, power, and *tessitura*, are as important as range. A contralto, or mezzo-soprano, operatic part may have as high a range as a light soprano part.

Tessitura of the voice is that part of the voice or compass in which it is possible to sing continuously with comfort. Tessitura of the part is the average level of the majority of notes in the part, not including the infrequent high or low notes. A contralto might have all the notes in the range of a soprano part but not be able to sing it without great vocal strain. Singing in the wrong tessitura has wrecked many a career.

Technique of Voice Production

Busoni's definition is as follows : " Technique is the easiest way to do any piece of work." How does this fit the singer's aim to produce all his notes in the right way at the right time with the required power, quality and duration, and with an acceptable pronunciation ? Technique should bring out the natural voice quality, range and power under easy, restful conditions, and should establish a method of articulation that does not interfere with voice production. For this we must obtain a " passive " condition of extraneous structures in the neck so that the necessary movements of the vocal mechanism (and no others) are easily made. Such a condition depends on the control of movements of the jaw, head, lips, tongue, and soft palate. (The last three will be discussed under " Articulation ".) The first part of the training is concerned with control of the head and jaw movements in manner, direction, and degree. In singing, jaw control is an essential part of articulation also. A slight backward nod of the head should accompany downward movements of the jaw and vice versa. In this way the greatest degree of jaw movement for open vowels is possible without interference with the larynx. If the primary object of this work is kept in mind, jaw control and head balance can be mastered, with a beneficial effect on the throat at the same time. The aim of this technique is *how* to produce the voice rather than *where* to place the voice—when the voice is produced under the right conditions " it places itself ". Sensations accompanying healthy singing are not necessarily constant even in voices of the same type on the same note. For practical purposes voice production must become a habit reflex, independent of articulation.

Articulation.—In the work on articulation care must be taken to maintain or improve the passive voice condition. Articulation is an active process independent of voice production and may or may not be accompanied by voice. A clear pronunciation depends on the control of lips, tongue, jaw, and soft palate movements, and the best foundation for this is a sound phonetic training. For English-speaking singers it would include the essential sounds of one language besides the mother tongue, because it is imperative for the singer to be able to make pure vowel sounds. The process is simple, but does not come readily to the southern English speaker. Amongst singers there seems to be an impression that clear enunciation has a bad effect on voice quality and that it is a practical impossibility to sing high notes on certain close vowels, for example *i* – *e* – *u* and *o*, using sound values of the international phonetic alphabet.[1] Allowing for a slight modification of *i* and *u* in extremes of range, the truth is quite the reverse. It is never necessary to distort the text in any circumstances. If the movable organs of speech play their part efficiently, the larynx is left to function freely. Active articulation may be a great saving of vocal effort. In this sequence of training time is saved by the opportunity of practising light

[1] *See* Alphabet Chart published by the International Phonetic Society, University College, London, W.C.1.

" passive " voice production during the work on articulation. Up to this point, singing technique for children and adults is identical. When the speech sounds have been mastered, the singer is ready for the second stage of voice production. This may be called the Amplification Stage. The first stage has for its object the *passive throat*. The aim of the second is to encourage the *open throat* under the same condition. Let us call it *the passive open throat* for convenience. It permits the development of mature natural voice quality and sonority under conditions of ease and comfort. If the inspiration phase of respiration is associated with the non-vocal primary function of breath, and the expiration phase carried out with a little conscious effort, an easy increase of respiratory movement takes place, with a corresponding increase of voice. This process is continued until there is a slight involuntary opening response from the pharynx which, however slight, is accompanied by a proportionate increase of resonance. When the singer becomes aware of this amplification sensation, an explanation of its cause will be helpful in preparation for conscious adaptation. It should be understood that the singer is to take a breath whenever he wishes, at this stage of development. With a " passive open throat " we can get greater sonority and richer quality with the same amount of breath-stream.

Breathing.—In the system of training which I use, breath control is not suggested until the voice is free, and the correct breathing habit is established during the work on voice production. By this time the singer is aware of the sensation of correct breathing. It is only necessary at this stage to indicate to him what he has already been doing. The response to the suggestion that he can control his breathing is usually easy and immediate. It is done by using all three component parts of the respiratory mechanism, namely, muscles of ribs, abdomen, and diaphragm. Once the singer realizes that he takes in more breath than he needs for singing, the question of reserve breath is solved without anxiety. Breathing is associated with rest and refreshment and not with conscious difficulty. Inspiration " seems " passive and expiration slightly active when under control. This may be called the combined Method of Control, or Old Italian Method.

Stance or balance.—The importance of balance or " stance " in singing cannot be exaggerated, even by a golfer. The position must be restful and there are at least nine different positions of rest on the feet. The position of the head must also be considered. An example of head balance may be seen in those who carry burdens on the head and it is of no less importance for the singer. Chaliapin had it to perfection.

Disorders of Voice Production

Wrong voice production may affect voice quality, range, power, and intonation. The quality may become unpleasant, with a loss of variety and resonance if the voice is forced by use of a stiff, tight production. Usually there is a loss of some high and low notes and one or two " breaks " may occur.

Faulty intonation, or singing out of tune, is a most serious disorder. If a singer cannot sing in tune, a singing career is out of the question. Assuming that the hearing is normal, the trouble may be caused by wrong production combined with an intense conscious listening to himself, instead of listening to the accompaniment, vocal or instrumental. When children sing out of tune at school they are usually told they " have no ear " and are not allowed to sing with the class. A wrong decision at this stage may have serious results for the child. With a little help in voice production the faulty intonation may disappear, even in children who cannot sing one note in tune.

Low voice press.—This is a curious intentional treatment of the last few lowest notes of the voice. It is common even with some well-known singers. In this disorder the chin is pressed back against the neck and causes loss of power and quality.

The glottal " shock " is also called stop or stroke, probably depending on degree of attack. The glottal shock gives an ugly, jerky staccato character to speech. It

is one cause of the barking character sometimes noticed in Wagnerian singing and has a disastrous effect in lyric passages, where smooth-flowing legato singing is required. Many German singers employ the glottal stop even in slumber songs, for example in the phrase " Schlaf nun ʔ ein ".

Sacrifice of pronunciation to voice production.—Despite all the evidence to the contrary, some singers cling to the belief that articulation interferes with voice production. Little or no attempt is made at clear pronunciation and certain sounds are overworked. We may hear an intrusive (*m*) before every initial *b*; and an (*n*) before *d* and *th* (voiced). On high and low notes of some singers, " ah " seems to do service for all the other vowels in English, as for example, " rah mah bah mah " for " remember me " (Purcell). This is the school of " *voice effect at any price* ".

Retracted pronunciation.—There may be two causes of throaty pronunciation. One is intentional, as in the school which advises the singer to " make the vowels as far back in the throat as possible so as to be near the vocal cords ". Voice production and articulation suffer equally from this method. The second is unintentional retraction and may occur with the singer who has made a habit of " voice at any price ". Later, if any attempt is made at clear pronunciation, anxiety about voice quality prevents the free use of tongue, lip, and soft palate, a throaty pronunciation is set up in " compensation " which interferes with voice production. The result is that this school of singing is provided with still more proof that " articulation does interfere with voice production ".

Breathing—" unbalanced breathing ".—Most singers take in too much breath for the vocal requirements of musical phrases of average length and power. The result is loss of balance between respiration and its work in singing. It interferes with the freedom of respiratory movement, causing lack of control in expiration. It has a bad effect on voice quality and is associated with wasted effort and fatigue. This overloading habit is quite common.

Audible mouth inspiration.—This disorder may be recognized by a noise or " gasp " accompanying inspiration. It is first noticed when a breath must be taken in the shortest possible time. Lack of breathing technique causes anxiety and prevents the complete opening of the glottis. Quick inspiration is accompanied by friction and wasted effort.

If this disorder is not corrected in the early stage it may become a habit and be a part of every inspiration. It is only necessary to try this type of breathing a few times in succession to experience its harmful effects—a dry painful sensation in the larynx and voice fatigue.

Emotional excitement may prevent the singer from becoming aware of audible inspiration and its consequences. Silent restful inspiration with open glottis should be a habit condition in breathing for the singer.

Sir Richard Paget said the first point he would deal with was the phonation of the vocal cords: the vocal cords in man behaved exactly like the lips of a trumpeter when blowing a trumpet. If anyone would try the experiment of using a trumpet mouthpiece without the trumpet he would find, supposing he knew the technique, that he could play scales on that mouthpiece and produce different qualities of sound, entirely by the adjustment of his lips. It would be a good thing if all who were interested in the action of the vocal cords would get hold of an accomplished trumpeter and allow him to show them what he could do with his lips in making a wide range of sounds and different qualities of sound; for the vocal cords, a little further down and not so easily accessible, were doing exactly the same thing.

Far more attention should be paid to the action of the false vocal cords. In his own work he relied almost entirely on the use of models. If he wanted to know what the vocal cords were doing, he made a rough model of rubber with suitable apertures and saw how the action was produced. On making a slit in the wall of a rubber tube through which air was blown, if was found that the slit would not vibrate like a reed

unless the vibrating part was coupled with a resonator which helped it. Without that resonator the slit would remain open (without vibrating) and the air came out continuously. What was the equivalent of the resonator in the human vocal cords? Clearly it was not in the windpipe, for this could not be altered in size or shape. He suggested that the "resonator" of the true vocal cords was formed by the false vocal cords. These formed a resonating cavity the volume and aperture of which gave the necessary variety of resonant pitch.

To return to the analogy of the trumpet mouthpiece: if the register of his instrument was high, the trumpeter used a small trumpet mouthpiece, giving a small cavity into which his lips delivered the vibrating pulse of air. In trumpets with low register it had been found by experience that the mouthpiece must be made bigger.

There was another function of the false vocal cords, very little known at present, but quite as certain as their function in providing resonance, and that was the differentiation between the *p* and *b*, and the *s* and *z* sounds. It was commonly said that the essential difference was that one phonated on the *b* and *z* and not on the *p* and *s*; but one could *whisper* both the *p* and the *b* and was not then phonating either of them. Therefore there must be another difference, and this also was entirely produced by the false vocal cords. His evidence for saying this was that in making models it was possible to produce either an unvoiced *p* or *b* sound with the same mouth closure but with different adjustments of the artificial vocal cords and of a small resonating cavity immediately above them. The real difference between *p* and *b* or *t* and *d* was apparently that a different adjustment was made of the opening between the false vocal cords and that between the true vocal cords. In the model there were two ways in which this could be done. Both the false vocal cords and the true vocal cords might be nearly closed, or they might both be open—that produced the *b* sound; or one of the openings might be nearly closed and the other open—that produced the *p* sound. Evidently the difference (in the model) was one of resonance.

The action of the false vocal cords was of extreme importance both in singing and in articulation. Some time ago he had the privilege of looking down the throat of Professor Oscar Russell, who had developed an ingenious laryngeal periscope which he could put down his throat, enabling him to speak in just the same way as a person who spoke while smoking a pipe. In this way the activity which took place around the larynx could be watched, and that activity was to him at least a complete surprise. The movements of the pharynx were directly related to facial expression. When he got Dr. Russell to smile or to scowl, he found that, along with the change in facial expression, there was an obvious change in the laryngeal expression. In other words, Nature had provided for the expression of emotion by night and by day—the visual expression was quite adequate during the day time, and the laryngeal expression gave corresponding characteristic sounds by which the emotions could be recognized during the hours of darkness!

NOTE.—For a description of the experiments referred to *see* the speaker's "Human Speech" (Kegan Paul, 1930), pp. 117-123.

Robert Curry said as a physicist he might suggest an explanation for some of the queries raised. Mr. Guthrie and Mr. Milner had stressed the importance of the "attack" of a given tone in singing. Obviously the question of the "attack" was connected with the synchronization of the beginning of expiration and the closure of the vocal cords for phonation. Expiration involved partial adduction or closing of the glottis, whereas inspiration involved the abduction or opening of the glottis. Therefore the factors induced by closure of the glottis at the onset of expiration were paralleled on the opposite side by what was called inspiratory phonation, namely the beginning of a "voice" sound on the inspiratory period of respiration. It was interesting to find this question of low voice "press" being raised by a singer. He had read in the literature published by singers on the question of technique a great

deal about low voice " press ", but never much about the mechanical action involved. They knew from the work of Dr. Tarneaud that the mechanical action of the larynx for low sounds involved, in the lowest pitches, a strong attempt on the part of the singer to depress the larynx in the neck and to render the internal laryngeal muscles extremely lax, in order that the normal period of vibration might be as low as possible, thus producing the very low pitches required. Therefore this low voice " press " resulting in a pushing back of the chin or a drawing of the chin into the neck and a very conscious attempt at retraction of the jaw and the lowering of the larynx as a whole, was presumably an over-emphasis of this general muscle action which had just been described. On the other hand very high pitches, the upper register or head register, particularly in a soprano and contralto, involved the drawing up of the larynx into the neck, the external and internal laryngeal muscles tensing the vocal cords to the utmost. Then the singer reached a high pitch beyond which it was impossible to go without passing over into a falsetto voice. Most of the disorders commonly encountered in singing were obviously connected with the extremes of voice production ; on the one hand, inspiratory phonation as against glottal shock and, on the other hand, low voice " press " as against the straining of the voice for very high pitches.

One point had not been mentioned, namely the necessity for determining the normal pitch range over which the singer could carry the voice, and the desirability of making sure that a composer had not written a given song over a pitch range that was outside the normal capacity of the singer. For example, in the productions of Mozart there was often a wider compass than was supposed to be within the capacity of singers of the present generation.

Finally, a simple question which he thought was associated with the actual mechanical action of the vocal cords was this question of what was meant by the tension or rigidity of the vocal cords proper. The tendency to draw a simile between the speech apparatus of the human being and the violin string in particular had led, firstly, to the unfortunate name—" vocal cords " and, secondly, to the mistaken impression that the vocal cords were stretched during the production of higher and higher pitches. This had obscured the fact that no such stretching action took place. The stretching might amount to at the most, a few millimetres, and the main factor involved was the change in the rigidity of the vocal cords themselves caused by muscle tension. Again, the vocal cords did not operate individually but as part of a coupled system including the ventricular bands or false vocal cords, the cavities of the ventricles or sinuses between the true vocal cords and the false vocal cords above them, and the pharynx and the oropharynx. In any sound uttered in speech or song or any form of vocalization that system acted in its entirety. Therefore the whole contour of the speech system changed to a greater or less extent for every variation in vocalization.

Obviously the removal of a certain area of the speech system might reduce the efficiency of the total mechanism involved, but in cases of excision of the tongue it had been possible for the patient to articulate a great many sounds quite audibly and intelligibly by the accommodation which took place mainly within the larynx. Conversely, when the whole larynx was removed, the use of the œsophageal opening with air swallowed into the stomach and then expired, had simulated the action of the vocal cords to produce a voice, though admittedly not of good quality, usually hoarse and of low pitch.

Cyril Horsford said that for those interested in the subject he suggested reference to a little paper which he had published in the *Practitioner* in October 1912, entitled " Why Voices Fail ". Nearly all the statements made by Mr. Milner would be found already put forward there, and although that was more than a quarter of a century ago he could not modify them or improve them in the least. A closer collaboration with the singing master would cure abnormalities of the voice by the removal of the faults which caused them.

United Services Section

President—Air Commodore H. E. WHITTINGHAM, C.B.E., K.H.P., F.R.C.P.Ed.

[*December* 12, 1938]

Preventive Medicine in Relation to Aviation

PRESIDENT'S ADDRESS

By Air Commodore H. E. WHITTINGHAM, C.B.E., K.H.P., F.R.C.P.Ed., D.P.H.

ABSTRACT.—*Introduction*—The progress of aviation.

The protection of communities against diseases liable to be imported by aircraft.

Relationship between the incubation period of infectious diseases and time taken by air journeys to distant lands.

Administrative measures for the sanitary control of air-traffic :—

The International Sanitary Convention for Aerial Navigation (1933).

The role of the Office International d'Hygiène Publique, and the Health Organization of the League of Nations.

The Public Health (Aircraft) Regulations, 1938.

Types of aerodromes for sanitary purposes.

Practical measures for the sanitary control of aerodromes and aircraft especially as regards insects, passengers, and freight.

Possible transmission of yellow fever by aircraft : antimeasures, including vaccination.

The protection of flying personnel against diseases due to flying.

(*a*) Vision—glare ; ocular fatigue of night and blind flying ; blacking-out ; night blindness.

(*b*) Hearing — noise ; aerial telephony ; middle-ear deafness, and excessive vestibular stimulation.

(*c*) Respiration—oxygen want.

(*d*) Fatigue.

(*e*) Digestion—ballooning of stomach ; air-sickness ; rations for long-distance flights ; water supply.

RÉSUMÉ.—*Introduction*—Les progrès de l'aviation.

Protection des communautés contre les maladies transmissibles par les avions.

Relations entre la période d'incubation des maladies infectieuses et la durée des voyages par avion dans les pays lointains.

Mesures administratives pour le contrôle sanitaire du trafic aérien :

La Convention Sanitaire Internationale pour la Navigation aérienne (1933).

Le rôle de l'office Intérnational d'Hygiène Publique, et de l'Organisation d'Hygiène de la Société des Nations.

The Public Health (Aircraft) Regulations (1938).

Types d'aérodrome du point de vue sanitaire.

Mesures pratiques pour le contrôle sanitaire des aérodromes et des avions, surtout en ce qui concerne les insectes, les passagers et la cargaison.

Possibilité de la transmission de la fièvre jaune par les avions. Prévention, y compris la vaccination.

Protection du personnel aviateur contre les maladies dues à l'aviation :

(*a*) Vision—éblouissement ; fatigue oculaire due à l'aviation de nuit ou aveugle sensation de trou noir devant les yeux ; héméralopie.

(*b*) Audition—bruit ; téléphonie aérienne ; surdité de l'oreille moyenne ; stimulation excessive du vestibule.

(*c*) Respiration—manque d'oxygène.

(*d*) Fatigue.

(*e*) Digestion—dilatation de l'estomac ; mal de l'air ; rations pour les longues étapes ; provision d'eau.

ZUSAMMENFASSUNG.—*Einleitung*—Die Fortschritte der Luftfahrt.

Schutz gegen durch Luftfahrzeuge verbreitbare Krankheiten.

Beziehungen zwischen der Inkubationsdauer der Infektionskrankheiten und der Dauer der Reisen nach fernen Ländern.

Gesetzliche Vorschriften für die Sanitätskontrolle des Luftverkehrs :

Das internationale Sanitätsabkommen für die Luftfahrt, 1933.

Die Rolle des "Office International d'Hygiène Publique" und der Gesundheitsorganisation des Völkerbundes.

The Public Health (Aircraft) Regulations, 1938.

Arten von Flughäfen für Sanitätszwecke.

Praktische Massnahmen zur Sanitätskontrolle der Flughäfen mit besonderer Berücksichtigung der Insekten, der Reisenden und der Frachten.

Möglichkeit der Verbreitung von Gelbfieber durch Luftfahrzeuge. Gegenmassnahmen, einschliesslich Impfung.

Schutz der Besatzung gegen die durch das Fliegen bedingte Krankheiten.

(*a*) Sehvermögen—Blendung, Ermüdung der Augen beim Nacht—und Blindfliegen, Schwarzsehen, Nachtblindheit.

(*b*) Gehörsinn—Lärm, Luft-Telephonie, Mittelohrtaubheit und übermässige Vestibularreizung.

(*c*) Atmung—Sauerstoffmange.

(*d*) Ermüdung.

(*e*) Verdauung—Magenaufblähung, Luftkrankheit, Rationen für lange Reisen, Wasservorrat.

AVIATION has progressed to a remarkable degree during the last decade, and more especially in the past three years, when this country, like many others, has become air-minded and record after record has been broken. In 1935, when King George V reviewed his Air Force at Duxford, on the occasion of his Jubilee, the expression that there was "a lot of sky" was common. Now, the picture is entirely changed : aeroplanes are to be seen daily ; there are over 200 Service and civil aerodromes, excluding privately owned ones, in England alone, and all types of aircraft have been greatly improved as regards carrying-power, comfort, speed, and range of flight. To-day Service machines travel at speeds varying between 180 to 350 miles an hour and have flown non-stop for 7,162 miles ; and the new air-liners of Imperial Airways have a top speed of 250 miles an hour and cruise at 200 miles an hour while carrying 40 passengers plus cargo. Many aeroplanes leave this country daily for foreign parts, and air-routes to various parts of the Empire have been opened and speeded up. The popularity of flying and the air-mindedness of the nation have been shown by the King's visits by aeroplane to R.A.F. stations ; the recent holiday trip of the Duke and Duchess of Gloucester to East Africa ; the historic journeying by Mr. Chamberlain to and from Germany during the recent crisis, when time was most important ; the flights of Cabinet Ministers and other high officials to outposts of Empire to help settle some difficult problem by personal contact ; and the wide use of air travel by business men for financial gain, and by Service men to obtain the maximum number of days' leave at home.

This development of aviation is not an unmixed blessing for, though it has greatly

increased the rapidity of transport between one country and another, and between continents—and so has brought various parts of the world closer together as regards time—it is a most deadly implement of war and there is the added danger of aircraft conveying infectious diseases, either by means of passengers or insects. This danger was foreseen several years ago by the health authorities in many countries, with the result that the International Sanitary Convention for Aerial Navigation was drawn up at the Hague, in April 1933, and has since been ratified by practically all countries in the world.

In this paper it is proposed to deal with preventive medicine, as far as it affects aviation, under two main headings :—

I.—The protection of communities against diseases liable to be imported by aircraft.

II.—The protection of flying personnel against diseases due to flying.

I.—The Protection of Communities against Diseases Liable to be Imported by Aircraft

The safeguarding of the masses against infection is of greater importance in public health administration than that of the individual, and it is justifiable, therefore, to consider this matter first. Journeys by air, from countries where the major infectious diseases (cholera, plague, smallpox, typhus, and yellow fever) are endemic to non-infected yet susceptible countries, are so rapid that they are usually completed well within the incubation periods of these diseases. This was pointed out by Air Commodore D. Munro (1925), and Massey (1933), and Table I demonstrates that the danger of importing these diseases to various countries by air is considerable unless adequate protective measures are undertaken by all concerned.

Table I.—Showing the Relationship Between the Incubation Periods for the Major Infectious Diseases and the Time Taken to Complete the Journey by Air Between Endemic Zones and the United Kingdom.

Disease	Incubation period (days)	Endemic area	Time taken to complete journey by air from endemic area to U.K. (days)
Cholera	2–5	India	4–5
		Iraq	2–3
Plague	2–6	India	4–5
		Iraq	2–3
		East Africa	4
		West Africa ..	3–5
		South America ..	4–5
Smallpox .. .	10–14	India	4–5
		Iraq	2–3
Typhus	5–12	Central Europe ..	2
		Russia	2
Yellow fever ..	3–6	West Africa ..	3–5
		South America ..	4–5

The administrative machinery for the health control of air-traffic is based on the International Sanitary Convention for Aerial Navigation, 1933, which specifies the maximum measures that may be imposed for this purpose, but leaves their actual application to each country concerned, the general aim being to make the necessary regulations as uniform as possible to lessen inconvenience to passengers and to cause the minimum of delay to air transport, otherwise the main object of such mode of travel would be defeated. The Office International d'Hygiène Publique, in Paris, through its Air Navigation Quarantine Commission, deals with the application of the Convention and continually keeps matters concerning the sanitary control of aircraft under review, from an international aspect, while through its delegates it maintains a close touch with the various governments who have ratified the Convention ; it is,

in fact, an international health-controlling bureau with the power to draft international agreements. The Health Organization of the League of Nations, on the other hand, provides an international intelligence service which promptly informs the health authorities throughout the world of the incidence of infectious diseases at various ports and airports. This epidemiological information is passed on weekly to the appropriate medical officers of health of each country by the health department of the government concerned, so that they are in possession of up-to-date particulars regarding infectious diseases and epidemics, occurring both at home and abroad. Thus, in the United Kingdom, this information is published and distributed by the Ministry of Health weekly through the agency of their " Weekly Record of Infectious Diseases at Ports, &c. " and by means of notices in the *London Gazette*. From this information medical officers of health of areas containing customs aerodromes furnish the appropriate customs officer and person in charge of each aerodrome with a written list of infected places. In addition, each government has drawn up its own regulations regarding the sanitary control of aviation, and in this connexion the Public Health (Aircraft) Regulations, 1938, issued by the Ministry of Health, are designed to prevent the introduction of infectious diseases from abroad into the United Kingdom by aircraft, and are applicable to all aerodromes officially recognized for customs purposes for the arrival and departure of all foreign-going aircraft, which are not permitted to land elsewhere. In the case of a forced landing of an aircraft entering the country from abroad, the commander must notify the local authority, or customs or police officer, as soon as possible, and the crew, passengers and cargo must not leave or be removed from the vicinity of the landing-place until permitted to do so by the local authority ; then the aircraft, if infected or arriving from an infected area, should proceed to a sanitary aerodrome : if the aircraft is unable to proceed, the passengers and crew may be allowed to continue their journey by other means, provided that they have given their names and addresses of intended destination to the local authority, who forwards the information to the local authority of the intended destination in each instance.

Prior to dealing with the actual working of the International Sanitary Convention for Aerial Navigation, it is convenient to consider the various types of authorized aerodrome. Aerodromes, on which aircraft legally may make their first landing on entering a country, or from which they may depart, are collectively termed " *authorized aerodromes* ", and include customs, sanitary and anti-amaryl aerodromes, as well as certain local areas (*see* Diagram I).

(i) *A customs aerodrome* must have an appointed medical officer, on call as required, in addition to a customs officer. There must be a well-lighted room for medical inspections, together with a room for the temporary isolation of infectious cases, and separate lavatories for the two sexes. An assistant health officer or local facilities for disinfection and deratization are not necessities.

(ii) *A sanitary aerodrome* takes the health control a step further, as, in addition to the requirements of a customs aerodrome, there must be an organized medical service with one or more sanitary inspectors to supervise such duties as disinfection ; equipment for taking and despatching material for laboratory examination, if the examination cannot be done on the aerodrome ; facilities nearby for the isolation, transport, and care of infectious cases, as well as for the isolation of contacts, separately ; apparatus for carrying out disinfection, disinsection and deratization ; and an adequate supply of good drinking water, and safe disposal of excreta, refuse, and waste water. In addition, the aerodrome must be protected against rats.

(iii) A sanitary aerodrome may be designated a " *local area* " if it is so sited as to be beyond all probable risk of contamination from without ; in addition, no one must enter or leave such an aerodrome except with the permission of the competent authority. If cholera, plague, smallpox, typhus, or yellow fever is present in the surrounding district, then, except for persons working on the aerodrome, no one is permitted to enter except by air.

(iv) In districts where yellow fever exists, either clinically or as proved by mouse-protection tests, preventive measures are taken still a step further, as an *anti-amaryl aerodrome* must, in addition

to conforming to the requirements of a sanitary aerodrome in a local area, be situated at least a mile to the windward of habitations, especially those of natives ; it must be kept free from yellow-fever-carrying mosquitoes, and provided with mosquito-proofed quarters for aerodrome staff, aeroplane crew and passengers ; quarters for the last-named must be separate, as passengers may require surveillance for a period up to six days before embarkation to ensure freedom from yellow fever.

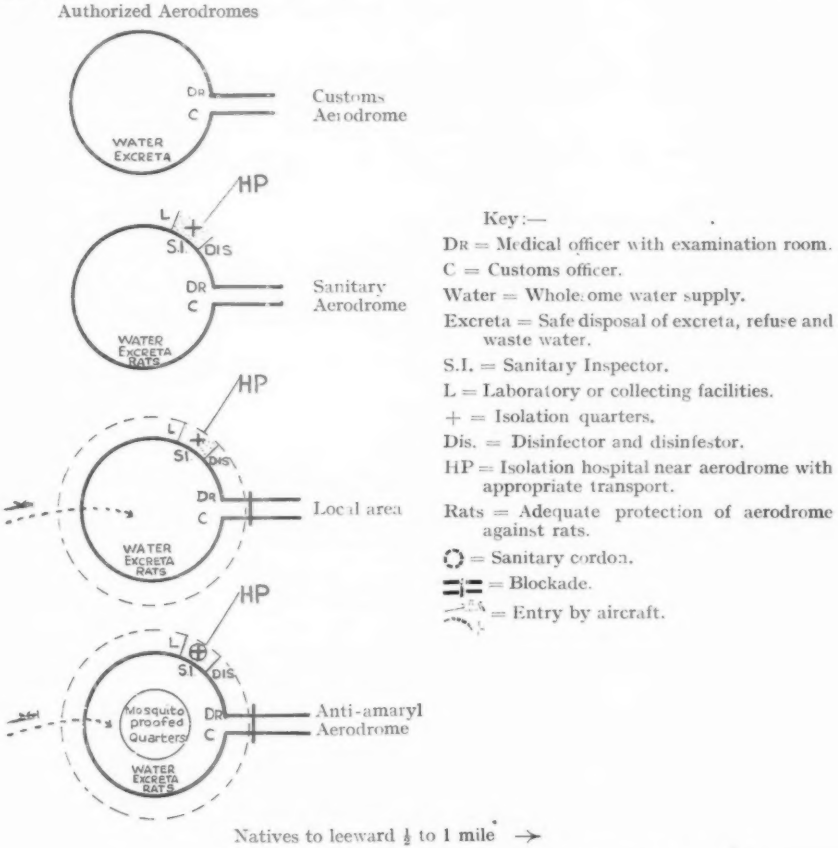

DIAGRAM 1.—Diagrammatic representation of various types of authorized aerodromes : there is a gradual transition from one to the other in the order—customs aerodrome, sanitary aerodrome, local area, and anti-amaryl aerodrome.

THE SANITARY CONTROL OF AERODROMES

In the case of aircraft arriving from abroad, if a death other than an accident occurs, or if there is a case or suspected case of infectious disease (other than tuberculosis or venereal disease) on board, the commander of the craft must notify the aerodrome medical officer or customs officer, preferably by wireless before arrival : if the person in charge of the aerodrome gets this information first, he must notify the medical officer and customs officer immediately.

Infected aircraft or those coming from places infected with cholera, plague, smallpox, typhus, or yellow fever, or those with rodents dying aboard, must not discharge passengers, crew, or cargo until after the medical officer has inspected them and declared them free from infection. The usual procedure is to isolate in hospital persons showing definite evidence of infection, while the contacts may be liberated (depending on the disease and the locality) after giving their names and addresses of destination, so that the appropriate local authorities are able to keep the contacts under surveillance during the incubation period of the disease. The customs officer is usually the first person to visit an aircraft on arrival and, if it is infected or suspect, he orders its detention and forthwith notifies the medical officer and the person in charge of the aerodrome of the fact. If the medical officer does not inspect an aircraft within three hours it is free to leave, and, should he not consider it necessary to inspect any aircraft and passengers, he may give a liberation certificate in writing to the customs officer concerned. It should be noted that no mail can be detained, disinfected, or destroyed, except packages containing fish, shell-fish, fruit, or vegetables coming from a cholera-infected area.

In brief, the sanitary control of arriving aircraft is along the following lines :—

(i) Medical inspection of passengers and crew ;

(ii) Isolation in hospital of infectious cases, other than tuberculosis or venereal disease ;

(iii) Surveillance of contacts, usually at home, during the incubation period of the disease, after de-lousing in the case of typhus contacts, and ridding of fleas of plague contacts ; adequate vaccination against smallpox or inoculation against cholera or yellow fever exempts from isolation ;

(iv) Disinfection of aircraft and infected articles in cases of cholera, plague, smallpox, and typhus ;

(v) Disinfestation of aircraft and personal belongings in cases of plague and typhus ;

(vi) Disinsection of aircraft in the tropics and subtropics to prevent yellow fever, dengue, and malaria-infected mosquitoes from being introduced into the country ;

(vii) Deratization of aircraft in case of plague or death of rodents on the voyage ;

(viii) Proper disposal of excreta on arrival, as it is forbidden to discharge excreta from the air, except over the open sea ;

(ix) The provision of a safe drinking-water supply, protected against mosquito breeding and, in the case of cholera, the water stored on board the aircraft must be disinfected and emptied out, then the tanks must be further disinfected before filling with wholesome drinking water ;

(x) Prohibition of the unlading of fresh fish, shell-fish, fruit, and vegetables, if there is a case of cholera on board or if the aircraft has come from a cholera-infested area.

As regards departing aircraft, passengers and crew are medically examined, if necessary, especially in areas where cholera, plague, smallpox, typhus, and yellow fever are prevalent. The aerodrome medical officer may prevent any person, who shows evidence of suffering from an infectious disease, from travelling by aircraft. He may also stop the embarkation of close contacts of any of the infectious diseases mentioned above, unless such contacts have been successfully vaccinated against smallpox within three years, or inoculated against cholera recently or against yellow fever within two years,[1] and, in the case of typhus, disinfested if necessary. In addition, he must ensure that no infected bedding, clothing, or articles, are taken on board, and that the aircraft itself is free from infection, e.g. freed of rats in a plague area or disinsected in a yellow-fever zone.

This leads to a consideration of the *journey log-book*, which all aircraft engaged on international flights must carry, and in which public health matters concerning aircraft and passengers must be entered. Such entries should include any sanitary action

[1] No definite period is stated for yellow fever, but the yellow-fever antibody content of the blood of those inoculated with virus vaccine is considered to be sufficiently high at the end of two years to ensure immunity in the majority of instances.

taken in regard to the aircraft at the port of departure or at places of call *en route*, as well as any health items that occur on the voyage, such as the presence in the aircraft of any person who requires surveillance. To facilitate the medical examination at the aerodrome of arrival an entry must be made if cholera, plague, smallpox, typhus, or yellow fever, has occurred in the area of departure within fifteen days; in certain countries, especially in the yellow-fever zones of the Americas, a "Certificate of origin of passengers" is demanded as an additional aid.

One hiatus in the International Sanitary Convention for Aerial Navigation is the fact that it does not apply to Service aircraft of any nation. Thus, as far as we are concerned, unless the Royal Air Force falls into line with the principles and spirit of this Convention, preventable disease may be spread by air to civilians and Service personnel alike, especially by aircraft moving from one command to another in tropical and subtropical countries. The matter is now under consideration at the Air Ministry and appropriate Service regulations will shortly be issued

Yellow Fever and Aviation

Yellow fever merits a section to itself, for special precautions have to be taken against this disease, as the mosquito vector (*Aëdes ægypti*) is so prevalent throughout the tropics and subtropics that, if the disease were introduced by means of a human case or by infected mosquitoes, a severe epidemic would result, especially as the infection would occur among highly susceptible peoples. In fact, the fear of this dread disease spreading to India by air traffic within the incubation period is so great that the Government of India has taken additional precautions to those laid down in the International Sanitary Convention for Aerial Navigation. Thus, passengers by aircraft from yellow-fever or suspected yellow-fever areas in Africa, are not permitted to enter India until nine days have elapsed since their departure from the affected area, and aircraft are not permitted to fly direct to India from such an area unless in possession of a certificate issued by the Egyptian Quarantine Board stating that the aircraft has been adequately disinsected. In common with the Dutch East Indies and the Sudan, India has prohibited the importation of yellow-fever virus, even for research purposes. As a further safeguard, India, Iraq, and Egypt, have mutually agreed to inform each other by telegram of any air-passenger coming from a dangerous area, while India further demands that a wireless message, stating the health condition of the aircraft, be sent to Karachi two hours before arrival.

That there has already been a recent spread of yellow fever from the endemic zones in West Africa eastwards is strongly suggested by Findlay's (1938) findings in the Malakal district of the Southern Sudan, for in 1933 only 1% of the population tested gave a positive yellow-fever response to the mouse-protection test, compared with 21% positive in 1938. As *Aëdes ægypti* is present in this district, it is assumed that the infection is of the urban and not the jungle type. Recently, there was a fatal case of yellow fever in a European, at Kouy, in the Sudan. It is evident, therefore, that yellow fever is occurring as far east as the Anglo-Egyptian Sudan, without classical symptoms, and only awaits suitable soil and exaltation of virus to produce a severe epidemic. Though this spread of yellow fever coincides with the opening up of the air-routes from West Africa to the Sudan, it cannot be affirmed that this has been the mode of spread of the infection, as motor traffic has also greatly developed at the same time, and anti-yellow-fever measures are more easily enforced in the case of aircraft than with motor-car traffic.

Nowadays, air-travel is so rapid that an aeroplane departing from the yellow-fever zones of West Africa reaches the Sudan in two days, Mozambique in four days, Durban in five days and, by another route, Karachi in five and Calcutta in six days, respectively; all these places are heavily infected with Aëdes. There is, therefore, great danger of yellow fever being spread by air-passengers incubating the disease

or by infected mosquitoes in the aircraft, unless special precautions are taken. Anti-yellow fever precautions are carried out on the following lines :—

(i) The provision of anti-amaryl aerodromes ;
(ii) A campaign against *Aëdes ægypti* ;
(iii) Control or isolation of intended air-passengers in yellow-fever areas before embarkation ;
(iv) Change of aircraft during journey to prevent direct transport of insects infected with yellow fever ;
(v) Destruction of mosquitoes in aircraft ;
(vi) Protective inoculation.

(i) It is desired to create *anti-amaryl aerodromes* in all yellow-fever and suspected yellow-fever districts ; such aerodromes have been established at Kano and Malakal ; Khartoum, being a junction and clearing place for air traffic, is also an anti-amaryl aerodrome, though not situated in a yellow-fever district.

(ii) A *campaign of destruction* has been instituted against *Aëdes ægypti* and other yellow-fever species, especially in anti-amaryl aerodromes and their vicinity. Since this campaign began the *Aëdes ægypti* indices in many places along the air routes of Africa have markedly declined, especially in West Africa.

(iii) Intending passengers may be required by health authorities to go into *isolation*, if necessary, for six days before embarkation. In Nigeria, seven days' notice of proposed flight is demanded, so that it can be decided whether quarantine in a mosquito-proofed hut is necessary before embarkation.

(iv) A *change of aircraft* during journeys lessens the risk of missed, infected insects being transported beyond a certain point. Land 'planes operate between West Africa and Khartoum ; here, other 'planes complete the journey to East or South Africa, or to Egypt, where another change is made at Alexandria before travelling on to India.

(v) The *destruction of mosquitoes in aircraft* has occupied the attention of many public health experts and aircraft constructors in various countries during recent years. Difficulties as regards the type of sprayer and insecticide to be used have had to be overcome. First, the ordinary "Flit" gun was used but proved of little practical value, as the spray produced was neither sufficiently fine nor penetrating. Pressure sprayers, driven by petrol engine or electric motor, were found suitable for aerodrome work but were too heavy and cumbersome for use actually during flight, which is the ideal method of disinfesting aircraft as it ensures destruction of insects before landing, as well as saving valuable time : disinfestation should be done just before or after taking-off and again from a quarter to half an hour before landing.

Park Ross, of South Africa, suggested building tracheal ducts into aircraft so that insecticide could be diffused through all internal compartments, but this idea was rejected, mainly on account of the great increase of weight involved. His visit to England in 1937, in connexion with this matter, however, brought to light the Larmouth carbon dioxide sparklet method of diffusing insecticides under pressure in the form of a very fine spray, which could penetrate all corners of the compartment treated, even behind curtains ; this result is attained by the pressure of carbon dioxide liberated by a sparklet bulb forcing the insecticide from a 50-c.c. metal container through fine copper tubing to jets in the compartment requiring to be treated. This year, an equally effective apparatus, the Phantomyst Nebulizer (made by André (Components) Ltd.) has been used for disinfesting aircraft ; by means of this apparatus, which weighs only 17 lb. and can be easily transported from one compartment to another, a dry and penetrating mist is formed by compressed air forcing the insecticide through fine jets to atomize it, then on to high-speed rotors, where it is pulverized ; the machine is calibrated to disperse 1 c.c. of insecticide a minute, and ten to fifteen minutes' action is required for a compartment of about 500 cubic feet. The sparklet ejector apparatus and the Phantomyst have been widely

experimented with by Imperial Airways, and for this purpose were fitted to their flying-boats *Cassiopeia* and *Cambria* on the Southampton-Durban run ; the results have been most satisfactory. A full report of these researches has been published recently by Mackie and Crabtree (1938), who stressed the necessity of placing the disinfesting apparatus in different positions in the compartments, depending on the normal continuous but slow flow of air currents from behind-forward in the aircraft, due to aerodynamic forces exerted on the outside of the machine. In flying-boats the sparklet ejector apparatus has been found most suitable for freight compartments and the Phantomyst Nebulizer most suitable for passenger compartments.

The choice of suitable insecticides for aircraft work is of prime importance for, as Mackie (1938) states, it should be :—

(*a*) Highly toxic to insects ; (*b*) innocuous to passengers ; (*c*) non-inflammable ; (*d*) non-corrosive and non-staining ; (*e*) stable in all climates and readily miscible with water.

Therefore, " Deskito ", which is a water-soluble pyrethrum concentrate, requiring to be diluted 10 to 14 times its volume with water immediately before use, has been adopted by Imperial Airways : the dosages which have been found essential (acting for ten minutes) to kill all mosquitoes in aircraft are from 50 to 150 c.c. of 1 : 14 Deskito per 1,000 cubic feet of space for the ejector apparatus, depending on the parts of the aircraft to be treated, and 30 c.c. of 1 : 10 Deskito per 1,000 cubic feet for the Phantomyst Nebulizer. Professor J. W. Munro recommends a 1 : 30 dilution of Deskito in water, using 150 c.c. for each 1,000 cubic feet of space to be treated and allowing the insecticide to act for fifteen minutes.

Pyrocide 20 is another very effective insecticide and is used widely in America, Egypt, and India, but as it contains a paraffin base, which with repeated application gradually saturates the walls and furniture of the aircraft, it so increases the risk of fire that it is considered inadvisable to use it.

Recent investigations by the Pan-American Airways, reported on by Cumming (1938), suggest that the present method of disinfesting the interior of aircraft is inadequate, as infected mosquitoes and other insects can find safe harbourage in the space between the outer and inner linings of the aircraft, or in the hollow wings, and can thus be transported to other aerodromes or forced landing grounds. In addition, he states that the exterior of the aircraft offers many hiding places for mosquitoes and instances the space which accommodates the retracted under-carriage, various grooves in the structure, and innumerable rivet holes. It is felt, however, that air currents during flight will dislodge most of these insects, but should later experience confirm Cumming's views, steps will require to be taken to disinfest these remote spaces and crannies.

As regards the prevalence of insects in the cabins of aircraft, the incidence varies with the site of the aerodrome, especially whether it is on land or water, and, in the latter case, the distance from the shore ; flying-boats usually moor well out at a floating pontoon. C. B. Symes found that of 52 aircraft arriving at Kisumu from the north, approximately 50% harboured insects, including culicine and anopheline mosquitoes, muscidæ, tabanidæ, and chironomidæ ; the insect population in these aircraft would doubtless have been far greater, but for the antimosquito measures practised at aerodromes. From Kisumu south to Durban, the local authorities have taken the additional precaution of trying to limit the entrance and exit of insects by hanging overlapping curtains, impregnated with para-di-chlor-benzine, over the doorway of aircraft. It would appear advisable to fit these curtains on all aircraft travelling over yellow-fever districts, especially in view of the possibility of such aircraft using re-fuelling aerodromes, which are mere clearings in the jungle, placed a reasonable distance from human habitations and supposed to be kept Aëdes-free. Incidentally, passengers are not permitted to embark at re-fuelling aerodromes without a special health certificate from the local medical officer of health.

(vi) *Protective inoculation with virus vaccine* has proved a most valuable preventive medicine measure against infection with yellow fever; protection begins about a week after inoculation and is fully developed in 90% of cases within three weeks, persists apparently for about two years, and is equally effective against urban and jungle types of the disease. Prior to 1937, the virus was given in conjunction with hyper-immune human serum with the result that, in about 3% of cases, infective hepatitis occurred three to four months after inoculation; at times the incidence was higher; thus, in Egypt, of 54 R.A.F. personnel inoculated against yellow fever with immune human serum plus attenuated viscerotropic virus, 7 men (i.e. 13%) developed jaundice three to four months later, whereas jaundice did not occur in any of the 996 R.A.F. personnel living under identical conditions, but not given this inoculation: the blood-sera of the jaundice cases following inoculation were tested and found to be free from yellow-fever-immune bodies in every instance. During the past fifteen months, however, an attenuated pantropic virus grown on chick embryo minus its central nervous system has been used; this virus has lost much of its viscerotropic and neurotropic properties, yet it produces a high degree of immunity to yellow fever; already 3,500 injections of it have been given in this country to people proceeding abroad and over 800,000 in Brazil, without the occurrence of a single case of jaundice. The assumption is, therefore, that the delayed hepatitis, which occurred previously after inoculation with certain batches of yellow-fever virus plus human immune serum, was due to the virus of infective hepatitis being present in some batches of human sera, analogous to the hepatitis, at times fatal, which has followed inoculation with measles and encephalitis-immune sera (Findlay and MacCallum (1937) and Propert (1938)). This defect has now been overcome by using only sufficient human serum to suspend the virus, that is 0·25 c.c. at each inoculation instead of about 30 c.c. as previously. The protective power of this virus inoculation is manifested by the fact that there has not been a case of yellow fever among 5,700 Britishers so inoculated before going to yellow-fever zones, whereas during this period there have been 40 cases of yellow fever among Britishers who were not immunized; moreover, nowadays, yellow fever does not occur among research workers in this field, though before the introduction of protective inoculation many distinguished workers, including Noguchi, Stokes, and Young, contracted the disease and died.

It is a wise precaution, therefore, for all those who intend to travel by air through yellow-fever districts to be inoculated with attenuated pantropic virus, to give them protection against infection and to facilitate their journey, as those so protected are not held up in quarantine.

The practical points concerning anti-yellow-fever inoculation are:—

(*a*) The virus is issued solidified in ampoules, which should be kept in a refrigerator or on ice at about 4° C.;

(*b*) When required for use, 1 c.c. of cold sterile water is added to the ampoule to dissolve the virus; the solution is complete in one minute;

(*c*) The inoculation needle must be cool and free of alcohol, otherwise the virus may be killed;

(*d*) The inoculation is given in the deltoid region at least fourteen days before the expected date of arrival in a yellow-fever zone;

(*e*) There may be a slight reaction about a week after the inoculation, the symptoms being headache, backache, lassitude, and low pyrexia (99° F.), which disappear in twenty-four hours and may be relieved with aspirin; there are no ill-effects such as jaundice;

(*f*) A certificate of inoculation should be given in each instance, as it may be required by the passenger on the journey;

(*g*) It is advisable to be reinoculated after a period of two years, if further exposure to infection is likely;

(*h*) In Aëdes-infected districts a mosquito-proof net may be kept around an inoculated person for three days after the inoculation, as the virus may be circulating in the blood, but this precaution is not essential as the amount of circulating virus is so minute and the virus itself so attenuated that it is unlikely to infect *Aëdes ægypti*;

(*i*) Persons performing inoculations should be immunized.

II.—The Protection of Flying Personnel against Diseases due to Flying

The safe piloting of aircraft under all conditions of weather, especially while landing and taking-off and during the performance of aerobatics at high speed, necessitates that pilots should possess a high degree of physical fitness. In the Service all flying personnel—pilots, observers, air-gunners, photographers, and wireless operators—should be alert in body and mind, with good muscle tone and quick reaction time, and should possess as well accurate vision and a good sense of balance. For these reasons, there is a continual endeavour on the part of the medical branch, working in close co-operation with aircraft constructors and various research workers, to improve any conditions of flying, whether connected with the aeroplane, flying equipment or man himself, which are proving detrimental to the well-being and efficiency of the personnel. In this connexion there have been many problems to solve concerning glare, ocular fatigue, blacking-out, noise, excessive vestibular stimulation, oxygen want, mental and physical fatigue, and air-sickness.

Vision

As regards affections of the eyes due to flying, the problems of counteracting glare, the ocular fatigue of night and blind flying, and blacking-out, arise.

Glare is specially liable to affect the eyes of aviators, when engaged in flying over clouds, desert, or water, also when flying towards the sun or when looking towards the sun in aerial warfare, real or mimic. Wing Commander P. C. Livingston, from 1930 to 1938, has done much valuable research on glare and its prevention, and, as a result, has been mainly responsible for the design and perfection of the present-day flying goggles and glasses, which give a full field of vision both in front and laterally as well as permitting binocular vision while landing—these were defects in previous designs. These goggles have been specially designed to fit and remain fixed at any speed to the flying helmet complete with oxygen mask, and to allow of immediate and easy adjustment to any desired position, as well as any width of nose. They are so constructed that triplex glass filters of various tints, appropriate for day or night flying, or suitable lenses for visual correction, can be instantaneously slipped in as required while flying. In addition, there is a dark visor which can be tilted into position in front of the goggles to enable the pilot to fly, or the air-gunner to take aim, if necessary, direct towards the sun with the minimum of glare effect. The antiglare value of these flying glasses has been highly spoken of by members of the long-distance flights in Vickers-Wellesley bombers, which took place to Egypt, via the Persian Gulf, early this year, and to Australia on last month's record-breaking flight. Recently, glasses have been made containing spluttered platinum or aluminium which, by their high refractive power, materially decrease glare and heat from the sun and at the same time give improved visual definition.

Ocular fatigue occurs during night or blind flying and is due to the rapid to-and-fro movements of the eyes while observing the various instruments on the illuminated instrument board. This has been overcome by a practical placing and grouping of instruments so that those most frequently looked at are concentrated in the line of vision. In addition, a weak plus lens is provided for insertion in the flying goggles or glasses for magnifying purposes, and any individual refraction errors are corrected.

Blacking-out.—Another problem which concerns both ophthalmologist and physiologist is that of *blacking-out*, a condition first encountered by aviators during the period of training for the Schneider Trophy race in 1929, at the time when aeroplanes had developed sufficient speed to produce centrifugal forces greater than 4 ' g ' while performing sharp turns. It also occurs when an aeroplane is being pulled out from a steep dive at high speed ; the sharper the turn, provided the speed is kept constant, the greater is the centrifugal force and its effect on the human body. The onset of blacking-out is sudden, but it does not occur immediately an excess over 4 ' g ' is applied, as there is a period of delay lasting a variable number of seconds,

depending on such factors as the amount of 'g' applied, the general physical and vasomotor tone of the person concerned, and the anticipation of or unpreparedness for the manœuvre performed (*see* Diagram II).

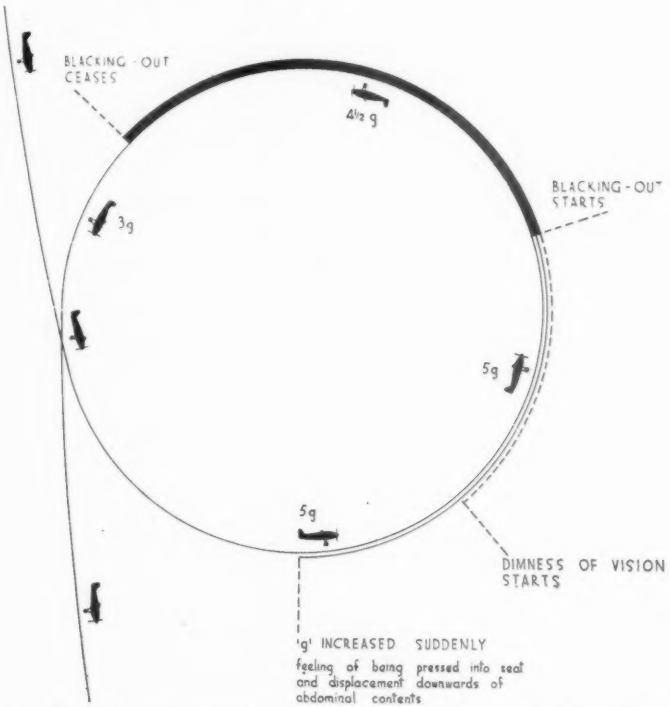

DIAGRAM II.—Diagrammatic representation of the process of blacking-out occurring during a steep dive or turn in aircraft at high speed.

The main effects of high 'g' on a healthy man are, first a feeling of being forcibly pressed into the seat of the aeroplane, then of the abdominal contents being displaced downwards; this is quickly followed by a gradually increasing dimness of the whole visual field, then sudden blindness or "blacking-out" occurs, but consciousness is retained, except in highly susceptible persons such as those with poor cardiovascular tone. The blacking-out period lasts a varying length of time, usually about two to five seconds, depending on the force and duration of the 'g' applied; it passes off as suddenly as it occurs while the loop or turn is being completed at a force less than 4 'g'. There may be a certain lack of mental concentration for a few hours subsequent to a blacking-out, but in the trained and fit pilot blacking-out does not occur readily and after-effects are not evident. The great danger of blacking-out is the momentary loss of control of the machine, which is liable to cause a collision with a neighbouring aeroplane during formation flying and tactics which are the order of the day.

To prevent or ameliorate this condition it is first necessary to understand the cause. In this connexion a considerable amount of research work has already been done, especially in Germany, and more recently in this country by Wing Commander

H. W. Corner and Flight Lieutenants J. B. Wallace and D. J. Dawson in high-speed aircraft. From these researches it would appear that the centrifugal force, acting from head to feet, causes most of the blood to flow in that direction, producing splanchnic pooling and increased volume of the lower limbs, as demonstrated by means of X-rays on monkeys by Fischer (1937). Thus, the head and heart are drained of much blood during the application of high ' g ', leading to a fall of the systolic blood-pressure, as shown by Ruff (1938) in Germany, by means of a centrifuge, and by Corner (1938) in this country, in high-speed aircraft. This lowering of the blood-pressure reduces the pressure in the central artery of the retina, which is normally about half that in the brachial artery (Magitot and Bailliart, 1922), to such a degree (Andina, 1937) that the balance between intra-ocular and vascular pressure is upset and as a consequence the circulation of blood in the central artery of the retina is stopped and thus causes complete blacking-out of vision until the said balance is readjusted by the return of the normal blood-pressure when the centrifugal force falls below 4 ' g '. At forces of less than 4 ' g ' the action of the carotid sinus reflex is sufficient, apparently, to prevent the blood-pressure falling low enough to cause blacking-out, as shown on dogs by Koenen and Ranke (1937).

Preventive measures were introduced first by the personal experience of pilots, who found that a certain amount of relief was to be obtained by yelling loudly during a steep turn or sharp pull-out, so as to contract the muscles of the abdominal wall and raise the diaphragm. This procedure brings to mind the observations of Flack and Bowdler (1920), who advocated that aviators should keep themselves physically fit and practise exercises to develop and maintain a firm abdominal wall. All flying personnel should keep physically fit, as this is a simple and effective means of lessening the ill-effects of high ' g '. The natural sequence of thought led to the trial of various types of belt to give increased support to the abdominal wall and so lessen splanchnic pooling. Flack (1929) provided members of the British Schneider Trophy team with a simple elastic belt, but this was soon discarded as being useless. Group Captain G. S. Marshall (1933) suggested the use of a safety-belt fitted with a spring-loaded scoop to inflate the belt with air under pressure of high ' g ', but its production has been delayed until recently. Flight Lieutenant J. B. Wallace carried out several experiments at North Weald in 1937 and 1938 with a specially designed abdominal belt fitted with a pneumatic bag to increase the pressure on the abdomen, and he found that it helped to prevent or delay the onset of blacking-out up to a force of 6 ' g ' in some individuals ; whereas Ruff (1938) in Germany, did not consider that abdominal belts were very successful in counteracting the centrifugal movement of blood to the dependent parts of the body. Instead, he suggested a form of folding chair, so designed as to bring the bodies of pilot or crew into a crouching position, so that the chest is pressed horizontally against the upper thighs, while the lower legs are drawn in under the thighs, as was recommended by von Diringshofen (1934 and 1936), at one time a German war pilot, after he had shown the benefit of this crouching attitude with regard to the higher endurance of powerful centrifugal forces ; this procedure materially reduces the difference in height between brain and heart, and so alters the axis of the body exposed to the centrifugal force that a sufficient blood volume is retained in the head and heart to prevent the occurrence of blacking-out. Wing Commander P. C. Livingston has suggested that the seat should be provided with an oleo fitting so that the first intense force could be dispelled by the seat sinking away as the gravity factor comes on, and thus, by neutralizing the effect of 1 or 2 ' g ' in this manner, no ill-effects might be felt as the result of a 5-' g ' manœuvre. Flight Lieutenant J. B. Wallace (1938) proved that the administration of oxygen does not delay or prevent the onset of blacking-out ; while Ruff (1938) showed that the administration of carbon dioxide raised the limit of endurance to centrifugalization.

Night blindness of mild degree is found occasionally in aviators, who not only find difficulty in seeing in the dark, but have a delayed visual adaptation rate when looking

from a lighted area into the dark, for example, looking from the illuminated cockpit to outer darkness or landing at night with flares. Squadron Leader J. C. Neely is at present investigating this subject with special reference to its incidence among flying personnel and its amelioration by the administration of vitamin A, which apparently plays an important part in the regeneration of the visual purple as shown by Mutch and Griffiths (1937), Maitra and Harris (1937), and Haines (1938).

A good eye lotion has been found very useful in relieving the tiredness of eyes during long flights.

Hearing

Noise in aeroplanes is mainly derived from engine explosions, from revolution of crankshaft and propeller, and from aerodynamic turbulence ; this noise is greatest near the engine and is radiated in closed machines from walls, floor, and roof, but not in equal degree ; thus radiation is greatest below the front windows and noise is least in the centre of the cabin.

The effect of noise on man depends on its level in the sound scale. Sounds between 80 and 90 decibels are disturbing, the degree depending on individual sensitivity ; whereas sounds above 90 decibels are deafening, the more so as the scale is ascended, and at or above 120 decibels they produce the feeling of pain. Continued exposure of the unprotected ears to sounds above 80 decibels will eventually lead to various degrees of nerve deafness ; such deafness would be occupational, leading to claims for attributability, except that all Service pilots are provided with special ear-pads to exclude noise, the onus to wear them being on each individual who enters Service machines. The progressive deterioration of auditory acuity in pilots, who have flown over a hundred hours without wearing ear-pads, has been demonstrated by Wing Commander E. D. D. Dickson (1938). Noise also leads to fatigue.

Examples of sound values.

80 to 90 decibels : Police whistle at 15 ft. ; motor horn at 23 ft. ; fire syren at 75 ft.

90 to 100 decibels : Pneumatic drill at 10 ft. ; newspaper press room ; inside cabin of aeroplane not soundproofed.

100 to 110 decibels : Boiler shop ; whistle of steam engine ; steel riveting machine at 15 ft.

110 to 120 decibels (this is the threshold of painful feeling) : Thunder (overhead) ; heavy gun-fire (close proximity to) ; unmuffled aeroplane engine (close proximity to).

In the non-soundproofed cabin aeroplane there is noise between 90 to 100 decibels in intensity. Aeroplane constructors, both in Europe and America, including Dryden (1930), Spain, Loye and Templin (1936), have studied the problem of the reduction of aeroplane noise and vibration and, as a result of the insulation of walls against sound and the provision of internal surfaces that give good sound-absorption, noise has been so decreased that conversation in an air liner of to-day is as easy as in a modern train.

In Service machines it is not practicable to reduce noise in this manner, owing to the question of weight. Instead, special ear-pads are provided as part of the flying helmet, at any rate for pilot, navigator, and wireless operator ; whereas, other occupants of the 'plane, e.g. personnel being transported in troop-carriers, usually just plug the external auditory meatus with cotton-wool. This latter procedure does not prevent the conduction of a certain amount of noise, both by air and by bone conduction ; the wearing of a flying helmet, if strapped under the chin, lessens this conduction.

Telephony between pilots and other members of crews in Service aircraft raises another problem of preventive medicine. The continued presence of a microphone in front of the mouth is annoying and therefore helps to hasten the onset of fatigue. Conduction of voice sounds by means of a microphone fixed either over the larynx

or sternum has been tried, but, so far, the results have been poor owing to distortion of voice sounds and absence of labial sounds.

Wing Commander E. D. D. Dickson is at present working in conjunction with Dr. A. W. G. Ewing of Victoria University, Manchester, and the Air Ministry Research Staff at Farnborough, to eliminate the effect of aeroplane noise on the ear and to perfect, if practicable, voice transmission and reception by bone conduction by means of a moving-coil microphone fitted over the sternum and an oscillator applied to the region of the mastoid process or over the brow while the external auditory meati are occluded.

Middle-ear deafness and excessive vestibular stimulation have also to be guarded against while flying. During steep and long ascents and descents, the balance of air pressure on the two sides of the tympanic membrane is so affected, especially by very rapid descents, that it is necessary to open the Eustachian tubes frequently by swallowing, aided perhaps by chewing gum, or forced blowing against the closed nostrils, so as to readjust the pressure to that of the atmosphere, otherwise tinnitus aurium, deafness, pain in the ears, or vertigo, result. Flying personnel should not be permitted to fly while suffering from cold in the head, owing to the danger of mucus or swollen mucous membrane occluding the Eustachian tubes and thus preventing the normal adjustment of the intra- and extra-tympanic pressures. Rapid descents, while there is obstruction of one or both Eustachian tubes, will either cause rupture of the ear-drum or excessive vestibular stimulation, leading to vertigo and vomiting with the possibility of serious consequences.

Respiration

Oxygen want or anoxæmia in altitude flying has been dealt with in considerable detail by various medical officers who served in the R.A.F. during the Great War, namely by Birley, Dreyer, Corbett, Bazett, Flack and Heald (1918), and their articles were revised and published in the Medical Research Council's Special Report, Series No. 53, in 1920. Group Captain G. S. Marshall (1933 and 1937) has brought the subject up to date in connexion with modern high-altitude flying. It has been proved that in the fit individual, as far as aviation is concerned, symptoms of oxygen want, such as dulling of the judgment and intellect, unwarranted sense of well-being and security, delayed reaction time, dyspnœa, and muscle weakness, do not usually occur until the height of 15,000 ft. has been reached and then only after the occupants of the aircraft have been at that height for about half an hour, though the time period varies greatly with apparently normal persons; of course, the symptoms occur much quicker if moderate exercise, such as air gunnery, is indulged in. Experiments in the decompression chamber have confirmed experience in the air and have shown that at 20,000 to 25,000 ft. without oxygen definite respiratory distress occurs rapidly as the result of such movements as operating a machine gun; heights above 25,000 ft. cannot be attained without the use of oxygen, as unconsciousness and death would quickly occur, owing to the low percentage of oxygen in the blood and tissues.

Table II

Height above sea-level (feet)	Partial pressure of oxygen in inspired air (mm. of Hg)		Partial pressure of oxygen in alveolar air (mm. of Hg)	Oxygen saturation of the blood in normal persons (percentage)
	Dry	*Wet*		
0	160	151	98	96
15,000	90	81	50	82
20,000	73	64	36	63
25,000	59	50	30*	50*
30,000	47	38	pressure at this altitude is insufficient to support life.	

* Presumed figures.

R.A.F. personnel are not permitted to fly at heights above 16,000 ft. without the use of oxygen, as man's mental and physical output is definitely reduced at this height, and correspondingly more so as greater heights are attained. Even at much lower altitudes, during long flights such as patrols, the administration of oxygen diminishes or abolishes the fatigue or staleness and increases the mental alertness and muscular vigour of the aviator, as was shown by Flack and Heald (1917 and published 1918). These important facts should be impressed on flying personnel, especially in war time, when the keenest judgment is needed on all occasions.

The present policy is to supply an increased percentage of oxygen in the inspired air for flights at heights between 16,000 and 35,000 ft., and for this purpose oxygen masks are fitted to all Service flying helmets and connected by suitable tubing to an oxygen cylinder so that each individual can turn on his oxygen supply as required : the oxygen flows constantly and mixes with inspired air in the mask, two-thirds being always lost as inspiration occupies only one-third of the respiratory cycle. Further research is now being planned to improve, if practicable, the present wasteful method of giving oxygen. For altitude flying above 35,000 ft. it is usual to supply pure oxygen under a pressure of 130 mm. of mercury to an individual enclosed in an airtight pressure suit somewhat resembling that of a diver (Marshall 1933) : in this manner Flight Lieutenant M. J. Adams, in June 1937, reached an altitude of 54,000 ft., a record only recently broken by the Italian, Colonel Pezzi, when he reached 56,000 ft. in October 1938.

Fatigue

Fatigue in aircraft crews, leading to diminished work performance, was dealt with by Air Commodore A. V. J. Richardson (1935) in his presidential address to this Section. He drew attention to the nervous exhaustion resulting from the cumulative effects of daily fatigue, which causes a continual drain of nervous energy, so that day after day the individual becomes less refreshed by sleep and less fitted for work ; this is apt to lead to psychological trouble. As regards aviation, there are various factors at work in causing fatigue, such as the stress of taking-off and landing at high speed, the mental anxiety of night flying or flying through cloud and fog, the discomfort of a confined and cramped position, vitality lowered through cold and draughts, the effect of noise on the auditory nerve, anoxæmia at higher altitudes, and the injurious effects of carbon monoxide if fumes enter the cockpit or cabin.

Preventive measures to combat these fatigue-producing factors have been conducted along the following lines. Robot-pilots, artificial horizon, aerial compass, and wireless, have done much to simplify night and blind flying. Attention to the design and positioning of seats has overcome cramping, especially in civil passenger aeroplanes. Air-conditioning of air liners has provided an agreeable temperature in the various compartments, in all climates, without draught ; owing to undesirable extra weight, this has not been found practicable in Service machines as yet, but for everyday flying in this country a special flying suit, consisting of a linen fabric outer cover, waterproofed inside and lined first with linen fabric, then with wool, has been provided, together with a lambskin collar, dyed nutria, but free from phenylene diamine, which is apt to cause dermatitis. In addition, there are flying boots and flying gloves ; the latter consist of three glove layers, the inner of silk, the second of cotton, and the outer of leather, to suit varying temperature conditions and permit of adequate cleaning. Of equal importance is the provision at all squadrons of well-ventilated drying rooms to ensure that flying kit is dry and warm before being put on. A so-called " thermally insulated " suit, consisting of leather outside, lined with a heavy sheepskin inside, is issued for conditions of extreme cold. Sound-proofing in air liners and the provision of special ear-pads in Service machines, as already described, have largely overcome the noise factor. Oxygen is provided to counteract anoxæmia, as already described. Attention to the positioning of the exhaust has done much to overcome the fume nuisance, though the occurrence of persistent

headache, not relieved by aspirin, in closed machines on long flights, suggests the possibility of carbon monoxide poisoning in mild degree: this requires further investigation.

Digestion

Ballooning of the stomach or intestines, due to expansion of the contained gases, tends to occur at high altitudes, especially in those who have lax abdominal walls and suffer from fermentative indigestion: this is increased by a too-liberal carbohydrate diet. The ballooning may seriously embarrass the heart and respiration. Relief may be obtained by proper dieting before flights and by the administration of a hydrochloric acid mixture during meals to aid digestion, as the hydrochloric acid content of the gastric juices is often low in such cases.

Diet of persons on long-distance flights has been experimented with, chiefly by means of trial and error, on the various long-distance flights, and one consisting mainly of carbohydrates has been found to be the most suitable, as muscular movements and exercise during flight are very limited and the main requirements are to maintain bodily heat and energy; in fact, as the flight progresses, especially in warm climates, it is found that the appetite is materially decreased. Table III shows a suitable flying ration for one person for a three-days' flight.

Table III.

Item	Quantity
Dried meat (e.g. pemmican or biltong)	2 lb.
Sandwiches, whole round	6 lb.
Chocolate, milk or plain	½ lb.
Oranges (bottled fresh juice)	12
Apples	6
Bananas	6
Dried dates	¾ lb.
Dried figs	¾ lb.
Dried raisins	¾ lb.
Sugar, lump	½ lb.
Sugar, barley	½ lb.
Chewing gum	½ lb.
Coffee, black, unsweetened	1 gallon
Malted milk tablets	½ lb.

In addition a bottle of glyco-thymoline, diluted 1 : 10, to rinse out mouth to lessen dryness.

Water is provided on desert flights on the assumption that it may be required for a minimum period of three days in case of forced landings. For this purpose water is carried on the scale of one gallon per man per day, that is, a quart in each water bottle, the rest being stored in tanks and, as already mentioned, these tanks require special treatment in cholera-infected areas.

In addition, for detached aircraft on flights abroad, a small meta-filter, complete with semi-rotary pump and 30 ft. of tubing, weighing 23 lb. in all, is supplied, together with sufficient bleach and ammonia to chloraminate the water filtered by means of this pump. For detached squadrons a small motor-driven plant for mechanically chloraminating water is provided; the whole apparatus packs neatly into two cases, each case being a 2-ft. cube and weighing 150 lb., so that it can be readily transported by aeroplane, motor car, or motor boat; the apparatus can be assembled for action within fifteen minutes and is capable of delivering 250 gallons of filtered, sterilized water an hour. One or more collapsible "sportapool" tanks complete the equipment.

Air-sickness, like sea-sickness, is considered by most authorities to be due to the abnormal excitation of highly sensitive vestibules leading to vagosympathetic disturbance and hypertonus of the stomach, as shown by Gwynne Maitland (1931) and Flack (1931). Liability to this condition can be assessed in the medical room by the type of response to spinning in the Bárány chair. By repeated exposure to these abnormal

stimuli the vestibule becomes adapted to them, as far as flying is concerned, at least in a certain number of cases. Wing Commander E. D. D. Dickson thinks that the adaptation rate is as high as 80%. On these grounds it is intended, as a temporary measure, to accept a limited number of candidates who show varying degrees of air-sickness and to send them to a particular flying training school, where they will receive a special course of training. There are other means of educating the vestibules to adapt themselves to aerobatics; thus in Russia and Germany use is made of rotating wheels. In addition, there are the usual aids for the " bad sailor ", that is, drugs of the barbiturate group, which act as sedatives on the nervous system and reduce muscle tone, including that of the stomach, but which, unfortunately, cause an uncomfortable dryness of the mouth. These remedies must, of course, be taken about half an hour before the intended flight and may require to be repeated during long flights.

As regards flying in warm climates, aluminium fabric sunproof blinds have been fitted in the roof of the cockpit of certain Vickers-Wellesley bombers and have proved of practical value as a protection from the sun; and at the present time the flying-helmet is being reconstructed so that it can be used in two layers, a light inner webbing layer for use in the tropics and in closed-cabin aircraft, over which can be worn a thick outer layer for use in open aircraft and under conditions of cold.

In conclusion, I wish to express my deep gratitude to the Ministry of Health, particularly to Drs. T. Carnwath, P. G. Stock, and M. T. Morgan, for their courtesy in inviting me to various departmental meetings dealing with aviation and general public health matters; to Imperial Airways, especially to Colonels H. Burchall and F. P. Mackie, for their ever-ready help, information, and co-operation on many occasions; and to the various R.A.F. medical officers who have permitted me to refer to their researches, some of which have not been published as yet.

REFERENCES

ANDINA, F. (1937), *Schweiz. med. Wchnschr.*, **18**, No. 33, 753.
BIRLEY, J. L. (1920), M.R.C. Spec. Report Series, No. 53, 5.
CORBETT, C. D. H., and BAZETT, H. C. (1920), *ibid.*, 18.
CUMMING, H. S. (1938), *Bull. Office internat. d'Hyg. pub.*, **30**, 1998.
DREYER, G. (1920), M.R.C. Spec. Report Series, No. 53, 10.
DRYDEN, H. L. (1930), *Tr. Am. Soc. Mech. Engrs.*, **52**, 107.
FINDLAY, G. M., and MACCALLUM, F. O. (1937), *Trans. Roy. Soc. Trop. Med. and Hyg.*, **32**, 323.
FINDLAY, G. M. (1938), *ibid.*, **32**, 323.
FISCHER, U. (1937), *Luftfahrtmedizin*, **2**, 1, 1.
FLACK, M. (1920), M.R.C. Spec. Report Series, No. 53, 14.
FLACK, M., and BOWDLER, A. P. (1920), " Medical Problems of Flying ". London.
FLACK, M., and HEALD, C. B. (1920), M.R.C. Spec. Report Series, No. 53, 14.
FLACK, M. (1931), *Brit. M. J.*, 176.
GWYNNE MAITLAND, T. (1931), *Brit. M. J.*, 171.
HAINES, R. T. M. (1938), *Tr. Ophth. Soc. U. Kingdom*, **58**, 103.
KOENEN, R., and RANKE, O. F. (1937), *Luftfahrtmedizin*, **2**, 1, 14.
LIVINGSTON, P. C. (1932), *Brit. J. Ophth.*, **16**, 577.
MACKIE, F. P., and CRABTREE, H. S. (1938), *Lancet*, 447.
MAGITOT, A. P., and BAILLIART, J. (1922), *Am. J. Ophth.*, **5**, 824.
MAITRA, M. K., and HARRIS, L. J. (1937), *Lancet*, October (ii), 1009.
MARSHALL, G. S. (1933), *J. Roy. Aeronaut. Soc.*, **37**, 389.
Id. (1937), *Proc. Roy. Soc. Med.*, **30**, 995.
MASSEY, A. (1933), " Epidemiology in Relation to Air Travel ". London.
MUNRO, D. (1925), *Pub. Health*, **38**, 271.
MUTCH, J. R., and GRIFFITHS, H. D. (1937), *Brit. M. J.* (ii), 565.
PROPERT, S. A. (1938), *ibid.*, 677.
RICHARDSON, A. V. J. (1935), *Proc. Roy. Soc. Med.*, **29**, 31.
RUFF, S. (1938), *Luftfahrtmedizin*, **2**, 1, 14.
SPAIN, C. J., LOYE, D. P., and TEMPLIN, E. W. (1936), *Tr. Am. Soc. Mech. Engrs.*, **58**, 1.
VON DIRINGSHOFEN, H. (1934), *Ztschr. f. Biol.*, **95**, 1.
Id. (1936), *Luftfahrtmedizin*, **1**, 226.
WALLACE, J. B. (1938), M.D. Thesis, Glasgow University.

Section of Radiology

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Radiation Therapy in Tumours of Bone

By J. Struthers Fulton, M.D.

Abstract.—Radiation can be shown to produce satisfactory results in the treatment of simple bone cyst, chondroma, angioma, and benign giant-cell tumour. It is of particular value in benign giant-cell tumour where there are grounds for the opinion that it should largely replace surgical methods.

Surgery remains the method of choice in the treatment of osteogenic sarcoma but where the lesion is inaccessible growth restraint may be obtained by the use of X-ray therapy.

Radiation, as a palliative measure, is of definite value in the treatment of bone metastases.

Myelomata are uniformly responsive to X-ray therapy, which is capable of prolonging life and relieving pain in these cases.

It is probable that radiation therapy is superior to surgery in treatment of Ewing's tumour if the diagnosis be made at an early stage of the disease.

Direct invasion of the bone by tumour should not be considered a contra-indication to radiation therapy, particularly if the tumour is of a type known to be radio-sensitive.

Résumé.—Il peut être démontré que la radiothérapie peut produire des résultats satisfaisants dans le traitement des kystes osseux simples, des chondromes, des angiomes et des tumeurs bénignes à cellules géantes. Elle est spécialement utile dans le traitement de ces dernières, et il y à lieu de penser que pour ces cas elle devrait le plus souvent remplacer la chirurgie.

La chirurgie reste la méthode de choix dans le traitement des sarcomes ostéogènes, mais dans le cas où la tumeur est inaccessible sa croissance peut être restreinte par l'emploi des rayons X.

La radiothérapie a une valeur indubitable comme traitement palliatif des métastases osseuses.

Les myélomes sont toujours sensitifs à la radiation, qui est capable de prolonger la vie et de soulager la douleur.

La radiothérapie est probablement supérieure à la chirurgie pour le traitement des tumeurs d'Ewing si le diagnostic est posé assez tôt.

L'invasion directe d'un os par la tumeur ne doit pas être considéré comme contre-indication de la radiothérapie, surtout si la tumeur appartient à un type reconnu comme radiosensitif.

Zusammenfassung.—Mittels Bestrahlungstherapie lassen sich bei der Behandlung von einfachen Knochencysten, Chondromen, Angiomen und gutartigen Riesenzelltumoren nachweislich gute Resultate erzielen. Besonders wertvoll ist die Bestrahlungstherapie bei gutartigen Riesenzelltumoren ; die Ansicht ist gut begründet, dass in solchen Fällen die Bestrahlungstherapie an die Stelle chirurgischer Massnahmen treten sollte.

Die operative Behandlung bleibt die Methode der Wahl in Fällen von osteogenen Sarkomen ; wenn indessen die Geschwulst an einer unzugänglichen Stelle ist, kann ihre weitere Entwicklung durch die Röntgentherapie gehemmt werden.

Als Palliativmassnahme ist die Bestrahlungstherapie bei der Behandlung von Knochenmetastasen zweifellos wertvoll.

Myelome sprechen regelmässig auf Röntgentherapie an ; in solchen Fällen kann hierdurch das Leben verlängert und können die Schmerzen gelindert werden.

Bei der Behandlung von Ewing'schen Tumoren ist wahrscheinlich die Bestrahlung chirurgischen Massnahmen überlegen, sofern die Diagnose im Frühstadium der Erkrankung gestellt wurde.

Direkte Knocheninvasion seitens des Tumors sollte nicht als eine Gegenindikation gegen Bestrahlungstherapie angesehen werden, besonders dann nicht, wenn es feststeht, dass die Geschwulst einer röntgenempfindlichen Gattung von Tumoren angehört.

THE role of radiation in the treatment of bone tumours has aroused considerable controversy, and opinions, even of people well qualified to judge, vary so widely that one is forced to conclude that it is not possible, at this stage, to make any dogmatic statement. The general consensus of opinion appears to be that radiation therapy is of little value in osteogenic sarcomata, yet successes are claimed by a number of workers ; and, on reviewing the literature, one finds in many instances where poor results were obtained, that the technical factors employed have been such that success was improbable either on account of the dosage given or the method of administration. Personal experience leads one to believe that this uniformly pessimistic outlook is not justified and that in radiation there exists a method of treatment which is of undoubted value in certain bone tumours, and is in some cases superior to any other form of treatment at present available. In this communication it is proposed to discuss four benign and four malignant bone tumours in which radiation therapy may be shown to be of value. The benign conditions are simple bone cyst, chondroma, angioma, and benign giant-cell tumour, while the malignant lesions are primary osteogenic sarcoma, metastases, myeloma, and Ewing's tumour.

General considerations regarding dosage.—Heretofore no hard and fast rules have existed in relation to the radiotherapy of bone tumours. In general, however, it may be stated that those workers who have endeavoured to go to the limit of tolerance have not met with success. In fact, in certain cases disaster has resulted from their courageous efforts. For this reason many have gone to the opposite extreme and have limited the treatment to dosage levels which could not with reason be expected to produce therapeutic results. Much of the statistical evidence available in the literature is not, therefore, representative of the possibilities of radiation therapy and may be misleading.

If we consider bone from the anatomical and physiological point of view we find that it differs from other tissues which we are commonly called upon to treat, first, because of its greater calcium content and correspondingly greater power of absorbing radiation, and secondly, in relation to its blood supply which, for anatomical reasons, may not be increased to the extent which is possible in the case of the soft tissues when subjected to an injury, either in the form of radiation or infection. It is this latter fact which would appear to be of greater importance. There is considerable ground for the belief that vascularity plays an important part in determining both the tolerance and the therapeutic response following radiation. Thus we find that in the case of a vascular area of skin, such as the scalp, very large doses of radiation may be tolerated, while dosage to a relatively avascular area, such as the back of the hand, must necessarily be limited or permanent damage will result. Similarly, lesions in a vascular bed, such as the skin of the face or scalp, respond well to radiation treatment while a similar lesion on the back of the hand will be cleared up with difficulty and only with a technique specifically designed to minimize the damage which will be caused to the normal tissues. A good blood supply would, therefore, appear to be necessary, not only to ensure the complete recovery of the normal

tissues, but for the production of satisfactory radiotherapeutic effects on the tumour. This view serves to explain why post-syphilitic epitheliomata of the tongue, with associated endarteritis, do not respond well to radiation, and probably, therefore, it explains why a bone tumour with limited facilities for expanding its blood supply presents a difficult radiotherapeutic problem.

In pursuance of this thesis I should like to put before you one other biological conception, namely that a dose of radiation may in fact be ineffective through being excessive, with the result that the vascularity of the normal tissues is so rapidly devitalized that the desired therapeutic effect is not obtained. This phenomenon is most commonly seen following radium implantations of the breast where a hard residual mass will frequently be found to consist of viable and potentially active malignant cells incarcerated in fibrous tissue produced as a result of the intense local radiation.

This vascular conception, therefore, determines the approach to the problem of radiation therapy in bone conditions and explains why techniques employing high dosage levels have not met with success. It likewise explains the futility of unduly small doses since radiation is, so to speak, already working under adverse conditions in relation to the vascularity of the tumour bed. The aim in treatment should be to deliver the maximum possible dose which will fall short of exciting a severe reaction. With this end in view it has been my practice to deliver a dose of 2,500–3,000 r throughout the tumour zone by daily treatments over a period of three weeks, employing radiation with an effective wave-length of 0·12 A.U. and with a dosage rate, with scatter, of 2–3 r per min. on the skin at 50 cm.

With this technique, at this dosage level, the reaction produced on the overlying skin will not exceed a brisk erythema with desquamation, the reaction subsiding almost completely within three weeks of the completion of treatment. Two months later the reaction will have entirely subsided, the vascular tissues will have readjusted themselves to the altered conditions which have been brought about, and it is then possible, and frequently advisable, to repeat this course of treatment.

The question of biopsy in bone tumours.—The desirability of obtaining histological evidence of growth type is appreciated by all, but many workers believe that in the case of bone tumours the risk of dissemination is so great that the procedure is not justified. A modified procedure which has given satisfactory results is that of aspiration biopsy, a needle of moderate size being inserted into the tumour and a portion removed within the lumen of the needle.

Simple bone cysts.—Scant reference is made in the literature to the treatment of simple bone cysts by radiation, yet this method of treatment will usually suffice to arrest the growth of the pathological process and induce a sclerotic reaction which will ultimately replace the cystic process. Two cases which received treatment by radiation only exemplify the type of response which may be anticipated following radiation therapy in this condition.

Case I (fig. 1).—R. McK., a boy aged 12, was first seen in March 1934 when he gave a history of a fall injuring his left arm six years previously. There was no evidence of fracture at that time but intermittent pain had been felt in the arm since the injury. On examination thickening of the shaft was palpable and X-ray examination showed a simple bone cyst involving the upper two-thirds of the humeral shaft. Treatment was carried out entirely by X-rays ; two diametrically opposed long narrow fields being employed and a dose of 3,000 r being delivered throughout the tumour zone by daily radiation over a period of three weeks. During the first year slight change only was noted following treatment, and in April 1935 an additional 1,500 r were delivered over a period of twelve days. Further improvement was noted following this treatment. When last examined at the end of 1938, four and a half years after the original treatment, X-ray examination showed almost complete regeneration of the cortex with considerable obliteration of the original cystic area. The patient is now doing a full day's work as an apprentice engineer.

(*a*) (*b*)

FIG. 1.—Simple bone cyst. (a) Condition before treatment. (b) Four years later.

Case II (fig. 2).—R. S., a boy aged 12, was referred for treatment in September 1935 complaining of a painless swelling on the anterior aspect of the right tibia which had been present for a number of years. X-ray examination at this time showed the condition to be that of a simple bone cyst. A single course of X-ray therapy was administered through two diametrically opposed long narrow fields, and a dose of 3,000 r was delivered throughout the tumour zone by daily radiation over a period of three weeks. No obvious change was noted until four months later when there was evidence of a sclerotic reaction around the cystic area. This has become progressively more marked until, some three years after treatment, the cystic area is almost completely sclerosed. Clinically the patient is symptom-free.

Chondroma.—Opinions are somewhat conflicting regarding the radio-sensitivity of chondromata. Most observers are of opinion that the response varies but that

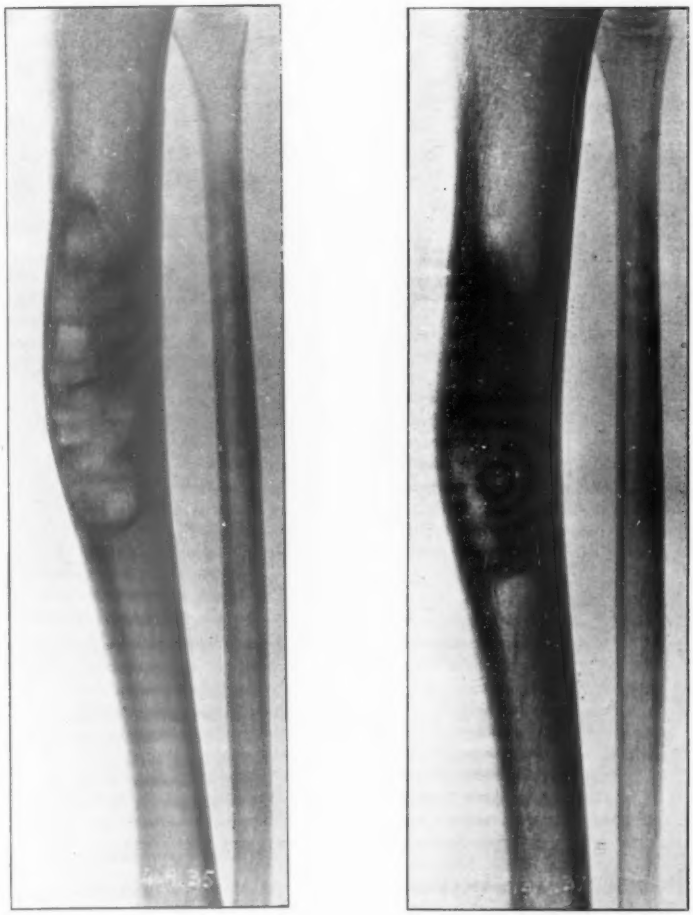

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FIG. 2.—Simple bone cyst. (a) Before treatment. (b) Two years later.

growth control is usually possible. It is probable that the response to treatment is, in some measure, governed by the site and extent of the lesion. The condition would appear to be favourable to radiation if the tumour be of limited extent or if it be at a site which makes possible the delivery of effective dosage. The following case illustrates the value of this type of treatment in preference to surgery, which might readily have produced a crippling effect.

Case III (fig. 3).—N. S., a boy aged 12, was admitted in July 1936 complaining of pain in the right hip following a slight injury three weeks previously. On investigation X-ray examination showed a typical chondroma involving practically the whole of the neck of the right femur with a moderate degree of expansion. Treatment was carried out by X-rays alone, three ports of entry being employed and a dose of 3,000 r being delivered to the area by daily radiation over a period

of three weeks. Sclerotic reaction was noted three months later, but as complete sclerosis had not occurred at the end of a year the course of X-ray treatment was repeated. This was followed by further improvement and when last seen at the end of 1938, two and a half years after the initial treatment, the patient walked well, without pain, and X-ray showed almost complete sclerosis of the tumour zone.

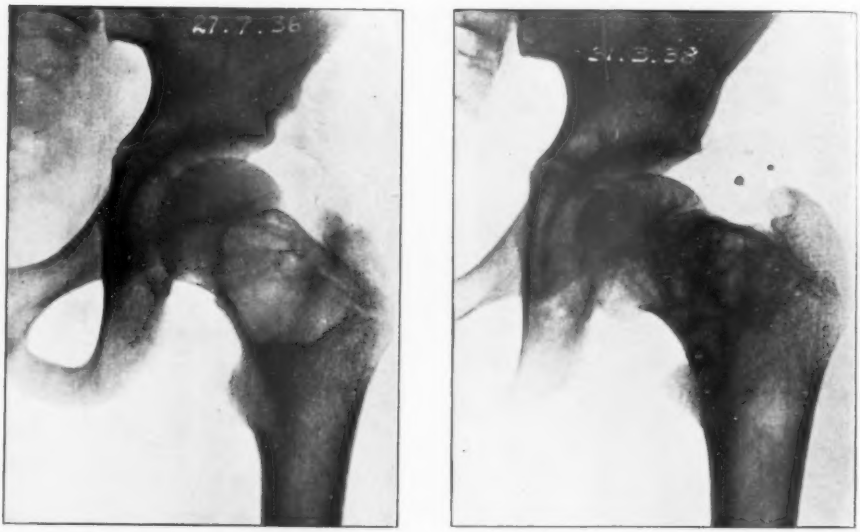

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FIG. 3.—Chondroma. (a) Before treatment. (b) One year and eight months later.

Angioma.—Angioma is a relatively uncommon lesion affecting, as a rule, an isolated vertebral body. During the last five years only three such cases have been referred for treatment at the Western Infirmary. The condition is amenable to X-ray therapy which is unquestionably the treatment of choice.

Case IV (fig. 4).— J. M., a male patient aged 47, sought advice at the hospital in June 1935 on account of pain, in the left kidney region, of six months' duration. Clinical examination was negative but X-ray examination revealed an angioma of the 4th lumbar vertebra. Treatment was carried out entirely by X-rays through three ports of entry, one anterior and two posterior, directed on to the body of the 4th lumbar vertebra, delivering a total dose of 3,000 r to the vertebral body by daily radiation over a period of three weeks. Symptomatic improvement was not obtained until four months after treatment. Following this the patient steadily improved and in due course a sclerotic reaction was noted in the diseased vertebra. The patient is now on full work as a waggon repairer and is quite symptom-free, three and a half years after treatment.

Benign giant-cell tumour.—It is a matter for regret that the value of radiation therapy for this condition does not appear to have been appreciated in this country. Elsewhere, radiation therapy has produced such satisfactory results in the treatment of benign giant-cell tumour that it is now regarded, practically without question, as the method of choice. The end-result of extensive curettage over a large area in close proximity to the articular surface of a major joint is frequently disappointing

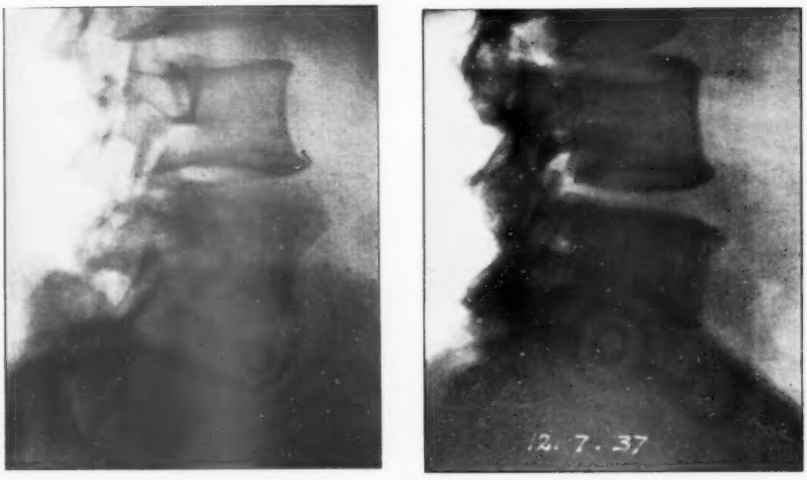

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FIG. 4.—Angioma. (a) Before treatment. (b) One year and seven months later.

due to collapse of the thin bony shell. The functional disability in these cases is such that one wonders why the surgeon has not sought a more conservative method of treating such lesions. Happily surgical opinion appears to be changing and I am fortunate in having been given the opportunity of treating a number of these cases entirely by X-rays.

Case V (figs. 5 and 6).—M. McL., a female patient aged 56, was admitted in April 1934 for pain and swelling of the jaw of nine months' duration. The right ramus of the mandible was found to be expanded over an area some 6 cm. in length, involving the molar, premolar, and incisor regions, and X-ray revealed a benign giant-celled tumour. For a period of three weeks the patient was treated by a combination of radium and X-rays, the radium being applied to the internal

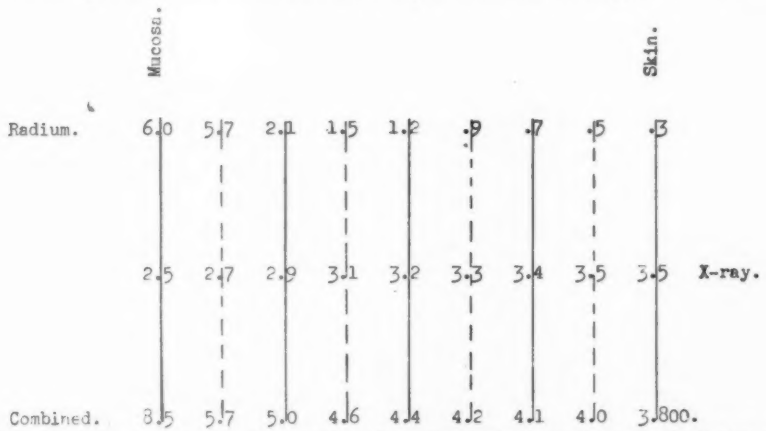

FIG. 5.—Energy distribution of combined radium mould and X-ray therapy field in Case V.

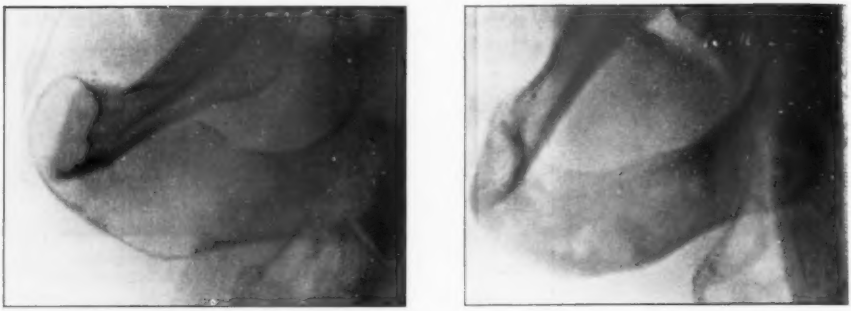

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FIG. 6.—Benign giant cell tumour. (a) Before treatment. (b) One year and nine months later.

surface of the alveolus on a dental mould, and the X-rays externally. A dose of 6,000 r was delivered to the mucosal surface by the radium mould and 3,500 r were delivered to the skin by the X-ray field. The combined dosage was such that the tumour received a maximum dosage of 5,700 r and a minimum dosage of 4,000 r. Details of the energy distribution are shown in fig. 5. Two months later there was clinical evidence of regression of the growth but no radiological change was apparent until about six months later. Thereafter, progressive improvement followed, and eighteen months subsequent to treatment the contour of the bone had been almost completely restored. When last seen in September 1938, four and a half years after treatment, the patient was symptom-free.

Case VI (fig. 7).—M. K., a female aged 45, sought advice in June 1934 for an intermittently painful swelling below the right knee, which had been present for about a year. On examination there was some slight fullness of the upper end of the right tibia, and X-ray showed a typical benign giant-cell tumour involving the upper end of the tibia with marked thinning of the cortex, particularly in relation to the articular surface. X-ray treatment was given through two diametrically opposed fields, delivering a dose of 3,000 r throughout the tumour zone in a period of three weeks. The first evidence of improvement was noted three months later. In a further six months sclerosis was not yet complete and a further 2,400 r were delivered to the tumour in a period of three weeks. Improvement following this was progressive, the walls of the cystic area becoming sclerosed and thickened and a general sclerosis occurring throughout the tumour. When last seen at the end of 1938, the patient was symptom-free.

In the treatment of bone tumours, but more particularly in the case of benign giant-cell tumour, there is one point which demands special attention. During the first eight weeks following treatment the reaction is such that considerable local decalcification occurs and the unwary observer might take the view that radiation was producing an adverse effect on the tumour. It is of the utmost importance to appreciate and recognize this characteristic change since any attempt at surgical intervention at this stage is usually unsuccessful.

Primary osteogenic sarcoma.—The general consensus of opinion among both radiologists and surgeons is that radiation therapy is of little value in the treatment of primary osteogenic sarcoma, and there is wide acceptance of the view that early radical surgery is the only effective means of treatment. While this view is undoubtedly correct one encounters cases in which, for technical reasons, radical amputation is not feasible and in such instances there would appear to be a field for radiation therapy. Osteogenic sarcoma, it is true, is a relatively resistant type of tumour but, given appropriate treatment, it may be made to respond to an extent which can produce, at least, effective palliation. This palliative treatment should

(*a*)

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FIG. 7.—Benign giant cell tumour. (a) Before treatment. (b) One year and nine months later. (c) Four years later.

be so designed as to avoid any severe reaction, and the dosage should be determined with a view to producing growth restraint. For reasons which have already been discussed, no attempt should be made to carry the dosage to a high level.

In some clinics it is the custom to subject the patient to post-operative irradiation of the chest following amputation of a limb for osteogenic sarcoma. This procedure, which is carried out as a prophylactic measure is, in my opinion, entirely unsound for two reasons. First, the dose which would be required to deal with a metastatic deposit from a tumour of this type is such that it could not be tolerated if delivered to the entire chest, and any lesser dose is unlikely to be of material value. Secondly, the radiation of a large volume of tissue, particularly in the chest and ribs, results in considerable damage to the blood, a complication which is far from desirable in any person suffering from malignant disease.

Case VII (fig. 8).—T. D., a male aged 45, was admitted to hospital in March 1936 complaining of an intermittently painful swelling in the right thigh of four months' duration. On examination a hard swelling was palpable on the antero-medial aspect of the upper third of the right femur, immediately below the lesser trochanter, and X-rays revealed an osteogenic sarcoma. On account of the site of the lesion and the uniformly disappointing results which had in the past followed radical amputation, the surgeon in charge of this case referred the patient for X-ray therapy. This was carried out over a period of four weeks commencing on March 28, 1936. Two large

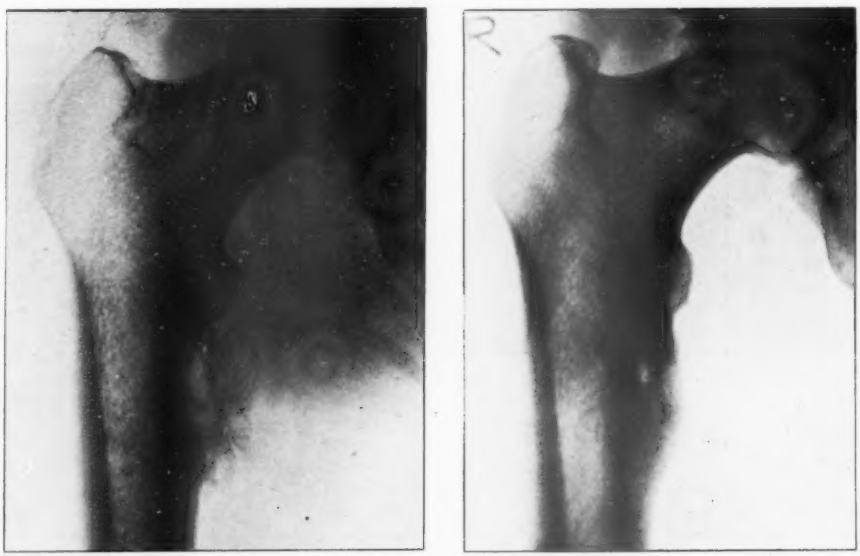

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FIG. 8.—Osteogenic sarcoma. (a) Before treatment. Two years and three months later.

rectangular fields were employed, anterior and posterior, and a dose of 3,000 r was delivered throughout the tumour zone in a period of three weeks. Improvement was first noted six months later, the bony spicules associated with the primary tumour disappeared and the palpable tumour decreased in size until the thigh was little larger than that of the other side. In June 1938, two years and three months after his initial treatment, the patient reported at the hospital and was found to have an oval swelling at the lower edge of the previously treated area. It was assumed that this was a local extension at the periphery of the treated zone and further X-ray treatment was accordingly undertaken, a dose of 3,000 r being delivered throughout the tumour zone in three weeks by anterior

and posterior fields. This was followed by regression of the tumour mass and, in view of the fact that there was no evidence of pulmonary metastasis, the surgeon was approached with a view to considering, once more, the possibility of amputation. This, however, was not deemed advisable, and it was decided to review the case periodically and attempt to control any further recurrences by radiation. The patient has resumed his normal occupation as a surfaceman.

Metastases.—Everyone is alive to the possibilities of effective palliation by means of X-rays in the case of isolated metastasis, and many workers have drawn attention to the great relief from pain which can be afforded to the patient by this means. Metastases from mammary carcinoma appear to be particularly amenable to treatment and one should never hesitate to treat an isolated bone metastasis from this condition. There is no justification for the view that, since the ultimate prognosis in metastatic bone tumours is hopeless, it is uneconomic to employ X-rays as a therapeutic measure. In such cases, if the demands for X-ray treatment be great, quite effective palliation might be carried out by the administration of a single massive dose of 1,000–1,500 r.

Case VIII (fig. 9).—J. N., a female aged 49, following removal of a malignant ovarian tumour three years previously, sought advice in April 1937 on account of pain in the left shoulder which had been present for about four months. On examination tenderness was elicited at the upper end of the left humerus with slight local swelling and X-ray examination showed an extensive area of bone destruction involving the medial portion of the upper end of the shaft. Further metastatic deposits were outlined in the scapula. It was decided to administer palliative treatment

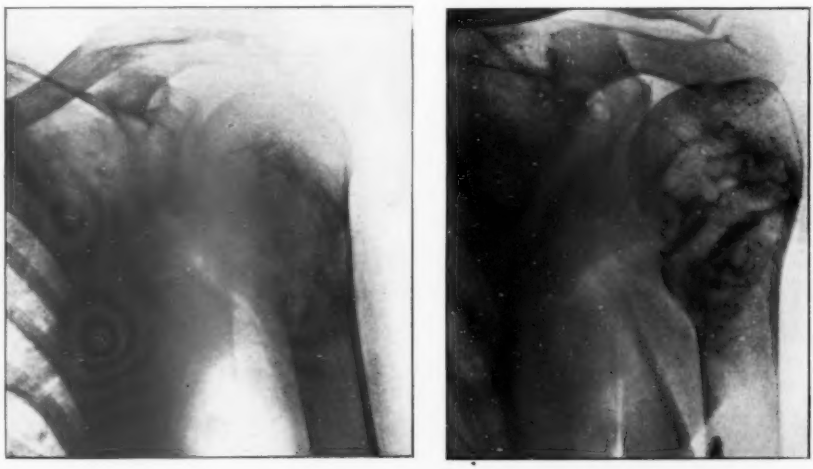

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FIG. 9.—Metastases from malignant ovarium tumour. (a) Before treatment. (b) Nine months later.

in the form of a single massive dose of X-rays. This was carried out through two large rectangular fields, anterior and posterior, a dose of 1,000 r being delivered throughout the tumour zone. This was followed by immediate relief from pain, despite the fact that X-ray examination, conducted one month later, appeared to indicate an extension of the lesion. A month later, however, there was obvious decrease in the size of the tumour and a sclerotic reaction subsequently developed at the site of the metastatic deposit. When last seen at the end of 1938, one year and nine months after treatment, she had no pain in the arm and movements were almost complete.

Myeloma.—While cases of isolated plasmocytoma have been described, most authorities are of opinion that this occurs somewhat infrequently as an isolated

lesion and that the condition is usually one of multiple myelomatosis. There is ample evidence to show that tumours of this type are uniformly radiosensitive and, for this reason treatment, although it be palliative only, should not be withheld. Definite, and in some cases dramatic, regression of tumour masses may be brought about, life may undoubtedly be prolonged, and considerable relief from pain is usually obtained.

Case IX (fig. 10).—J. F., a female aged 60, was admitted to hospital on February 5, 1938, complaining of a swelling of the left clavicle which she stated had been present for over a year. On examination there was a tumour mass, some 10 cm. in diameter, apparently originating on the inner half of the left clavicle and bulging anteriorly. X-ray examination showed the medial half of the left clavicle to be expanded with coarse trabeculation. A provisional diagnosis of benign giant-cell tumour was made but it was decided to perform a biopsy. Prior to obtaining the pathological report treatment was commenced on the assumption that the condition was one of benign giant-cell tumour, the proposed scheme being to deliver 3,000 r to the tumour in three weeks. At the end of the first week the pathological report was to hand, showing the condition to be one of plasmocytoma. Treatment was arrested at this time, after the lesion had received a dose of 1,000 r and, despite the moderate dosage given, considerable tumour regression followed.

Ewing's tumour.—Most authorities are agreed that Ewing's tumour is comparatively radiosensitive. Unfortunately the diagnosis is frequently not established

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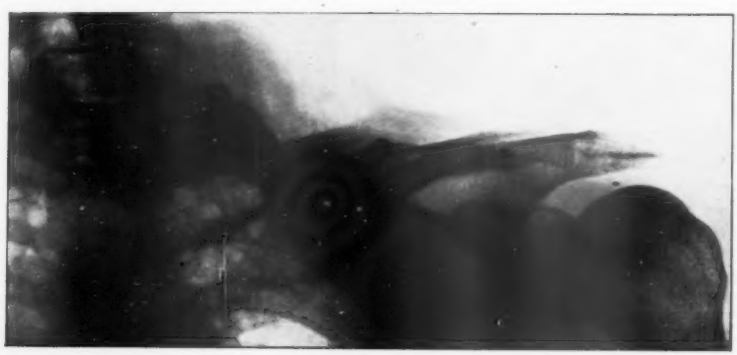

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FIG. 10.—Myeloma. (a) Before treatment. (b) Six months later.

until after surgical intervention has been undertaken and dissemination has, in all probability, occurred. If, however, an early diagnosis can be made, radiation therapy would appear to offer a reasonable measure of success without the disability following amputation.

Case X (fig. 11).—W. P., a young man of 21 years, was admitted in October 1936, complaining of pain and swelling, of two months' duration, in the lower part of the left thigh. On examination there was an ill-defined swelling over the lower third of the left femur apparently associated with the bone, and X-ray examination revealed a localized area of rarefaction with considerable periosteal reaction in the lower third of the femur—this, in parts, being suggestive of the onion-like layering seen in Ewing's tumour. There was no evidence of pulmonary metastasis. No biopsy was performed, but in view of the clinical and radiological diagnosis of Ewing's tumour it was decided to treat, in the first instance, by X-rays and to determine the further course in relation to the initial response. Treatment was carried out over a period of two weeks commencing October 8, 1936. Two large rectangular fields were employed and a dose of 2,000 r was delivered throughout the tumour zone. Immediately following this there was evidence of decalcification, giving an impression of extension of the rarefactive process. A month later, however, the tumour had decreased in size and X-ray examination showed commencing sclerotic reaction. In view of this favourable response it was decided to continue X-ray therapy and a further 2,000 r were delivered throughout the tumour zone by weekly radiation over a period of six weeks. The

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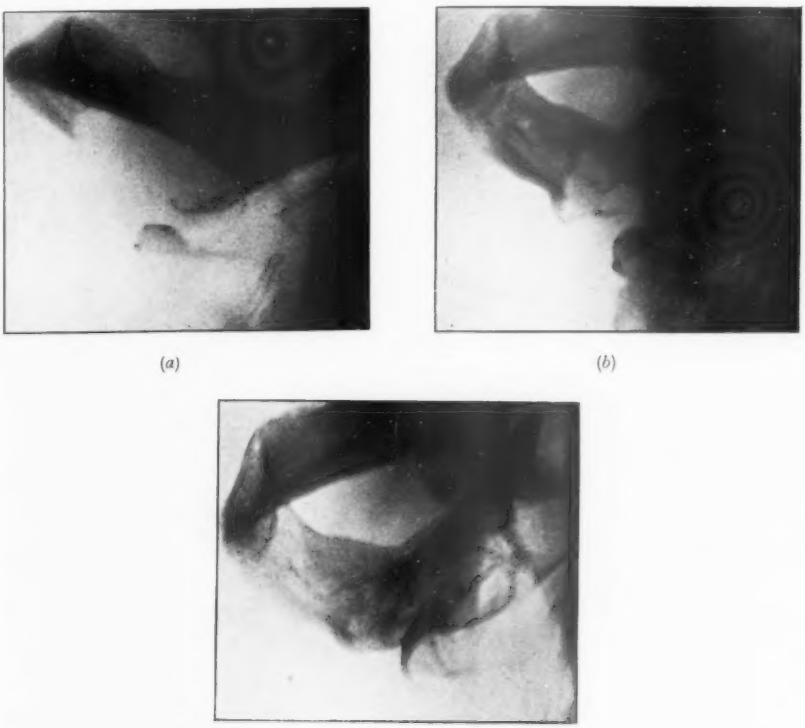
FIG. 11.—Ewing's tumour. (a) Before treatment. (b) Two years and three months later.

initial favourable response has been maintained and when recently seen, two years and three months after the original treatment, the patient was enjoying perfect health, doing a full day's work, and the shaft of the femur showed only local sclerosis at the site of the original lesion.

In conclusion I should like to mention one isolated case which, while not fitting into any of the eight headings which I have discussed, is of particular interest in relation to radiation therapy in tumours of bone.

Case XI (fig. 12).—P. D., a man aged 56, was admitted in November 1931 complaining of a swelling of the right jaw which had been present for some six months. On examination he was found to have a tumour involving the floor of the mouth and the mandible on the right side. X-ray examination showed extensive replacement of the right side of the mandible by tumour



(*a*) (*b*) (*c*)

FIG. 12.—Round celled sarcoma invading jaw. (a) Before treatment. (b) Four months later. (c) Four years later.

tissue. Biopsy showed the condition to be one of round-cell sarcoma. The case was treated entirely by X-rays, three fields being employed, delivering an estimated dose of 3,000 r to the tumour zone in a period of three months. The tumour cleared up completely and the jaw is almost fully regenerated. This patient is symptom-free seven years after his treatment.

It is a pleasure to acknowledge the very helpful co-operation which has been extended to me in the investigation and treatment of these patients by my medical and surgical colleagues on the staff of the Western Infirmary, Glasgow.

Section of Otology

President—E. D. D. Davis, F.R.C.S.

[*December* 2, 1938]

DISCUSSION ON INTERNAL-EAR DEAFNESS

Mr. F. W. Watkyn-Thomas: By "internal-ear deafness" we mean deafness due to changes, primary or secondary, within the cochlea itself; that is to say, deafness consequent upon changes in the nerve fibres or endings of the organ of Corti or in the cells of the cochlear ganglion. Differential diagnosis is from lesions of the nerve-trunk and its central connexions on the one side, and from lesions of the middle ear on the other.

(1) From lesions of the trunk and connexions: The *general features* of the central lesions are those of increased intracranial pressure, often associated with interference with the 5th and 7th nerves. The *special features* are summarized in this table, adapted from Brunner.

Lesion	Onset	Deafness	Course	Labyrinth
Acoustic Tumour—				
Lateral	Early symptoms	Homolateral	Slow	Inactive
Medial	Late symptoms	Homolateral	Slow	Decreased or inactive
Mid-brain	Late	Bilateral or contralateral	Rapid	Overactive
Brain-stem	Late	Bilateral	Rapid	Inactive
Hydrops	Late	Homolateral	Variation in intensity	Normal or decreased

"Hydrops labyrinthi", according to Brunner, is caused by pressure of a tumour, especially in the cerebello-pontine angle, on the veins draining the inner ear. This view is generally accepted. The question now arises whether general raised intracranial pressure can so raise the pressure of the perilymph as to cause intracochlear disturbance.

Another point arises in this connexion. Is there any means available of distinguishing between a lesion sharply limited to the nerve-trunk, such as a localized neuro-meningitis, and a lesion of the cochlea? As far as I know there is none; possibly some development of the estimation of the chronaxis of the nerve might be worked out, as has been done by Gosta Dohlman for the vestibular nerve.

(2) From lesions of the middle ear: The cardinal signs of internal-ear deafness are

shortening of bone conduction, lowering of the high-tone limit and, in consequence, a shortened positive Rinne response, with lateralization of the Weber test to the better side. Dida Dederding holds that in true internal-ear deafness the loss of high tones is proportionate for air and bone, as tested by the monochord. There are other peculiarities which are suggestive rather than decisive and will be considered later. But, first and foremost, we should make it a general rule that a diagnosis of internal-ear deafness must never be made until we are sure, by actual proof, that the Eustachian tube is patent, and the membrane mobile. I think it was Mr. Sydney Scott who first showed me that an obstructed tube with an impressed membrane can produce many of the signs of internal-ear deafness, and that when the obstruction is removed the hearing returns to normal and the signs disappear. In these cases I have found that, although there is a shortened " positive Rinne " with some loss of bone conduction for a fork of 256 d.v. and loss of high tones by air, there is no loss of high tones by bone conduction to the monochord.

I am certain of this as a clinical fact ; the physiological explanation is obscure. If it is true, as held by some, that the high tones reach the cochlea by the round window it is possible that, in these cases, the loss of high tones by air conduction is due to alteration in the tension of the membrana secundaria of the round window. (It has been suggested, from some results obtained by Hughson and Crowe on the Wever-Bray response, that an increase of pressure at the round window can *increase* the hearing power. It is important to remember that no confirmation of this has since been obtained.)

The loss of bone conduction may be due to inward displacement of the stapes by the membrane and ossicles, and would thus resemble the fading of bone conduction in the Gellé test, when the stapes is forced inwards by pressure in the meatus. Kobrak has shown that fixation of both windows with plaster of Paris abolishes all sound whether by air or by bone as shown by the stapedius reflex. Does it also abolish the electrical responses to bone-conducted sound ?

In estimating the loss of high tones, especially by bone, there is often a disparity between the high-tone limit, as estimated by the monochord, and the loss as shown by audiometer. In my experience the loss shown by the audiometer is always greater than that shown by monochord. As far as I know, no attempt has been made to estimate the intensity of the monochord sounds ; if this were done it might help to clear up the confusion. This is especially important in the diagnosis between true internal-ear deafness and otosclerosis. Dederding, in her paper, finds no loss of high notes by bone conduction to the monochord in otosclerosis. This has not been my experience ; in advanced cases of otosclerosis I am convinced that there is often secondary degeneration of the cochlea. In this connexion I have seen several cases of clinically unilateral otosclerosis of the " cochlear " or Manasse type, in which it is generally admitted that the deafness is of the internal-ear variety, where skiagrams by Dr. Graham Hodgson showed otosclerosis in the good ear, although hearing tests revealed no abnormality.

The diagnosis between primary internal-ear deafness and secondary nerve deafness in a long-arrested but resurgent otosclerosis may be of the greatest importance ; in middle life a small degree of primary internal-ear deafness is rarely actively progressive, an awakened otosclerosis may advance with formidable rapidity. In such a case, if the hearing tests are inconclusive, a skiagram of the labyrinths will often supply the answer. The symptoms of internal-ear deafness are those which we would expect from the hearing tests. As there is a loss of high tones rather than low, the patient's greatest difficulty is in general conversation, where we have to depend on overtones to distinguish one voice from another ; as his bone conduction is affected he does not find using the telephone easier than listening to ordinary speech ; as he can hear low tones well he is deafened rather than helped by noise. This is almost diagnostic between the otosclerotic and the patient with primary internal-ear deafness ;

the otosclerotic, even when he does not regard noise as helpful, is happily indifferent to it. This reaction to noise of the nerve-deafened patient is a point of considerable interest. It is probable that in the normal subject noise causes contraction of the stapedius muscle, with partial immobilization of the stapes and diminution of the acuity of hearing. If the subject's hearing is already below normal, such a mechanism will reduce it uncomfortably, provided always that the stapes is mobile; but the otosclerotic, with the immobilized stapes, will be entirely unaffected. Further, a loud noise in one ear can probably produce a bilateral stapedial response. This probability must be remembered when we attempt to mask one ear by the Bárány noise-machine or otherwise while testing the other. Diplacusis is common in internal-ear deafness, but it is not unknown in cases of pure middle-ear deafness.

Islands of deafness are common in internal-ear deafness, especially in cases where the deafness is due to trauma. I have never found them in true middle-ear deafness, but I believe that they have occasionally been found in otosclerosis.

The causation of internal-ear deafness.—In considering this there are three factors which we must take into account: the blood-stream, the endolymph, and the perilymph. Changes in any one of these circulating fluids may affect the nerve supply of the organ of Corti. The simplest example is invasion of the perilymph space by organisms in suppurative labyrinthitis or, by the internal route, in meningococcal meningitis. Such gross manifestations as these do not concern us now, but there are minor invasions which will demand consideration. The circulatory arrangement of the cochlea is peculiar. The arterioles of the stria vascularis are of the same calibre at entrance and emergence, and in the organ of Corti itself no capillaries can be detected; from this last fact it has been suggested that the tissue exchange of the organ of Corti is through the endolymph. It will be remembered that Mr. Hallpike drew our attention to this point in his recent paper on Ménière's syndrome. But it is not easy to prove a causal relationship between arterial changes and internal-ear deafness. I do not minimize the possible importance of vascular changes: we see the clinical association of arteriosclerosis with high-tone deafness too often to dismiss it as insignificant. I only remark that pathological proof of the correlation is lacking. Crowe, Guild, and Polvogt carried out an extensive research on the temporal bones of 79 patients who during life had shown high-tone deafness with normal hearing for low tones. They confirmed the opinion, postulated by Helmholtz and supported by much experimental work in recent years, that the receptors for high tones are in the basal turn of the cochlea, and were able to separate two groups of cases: A group in which there was a gradual dropping off of high tones with atrophy of the cochlear nerve supplying the basal turn, and a group in which there was an abrupt fall, with atrophy of the organ of Corti, especially in the external sulcus.

The patients in the first group were nearly all over 59 years old and showed generalized arteriosclerosis, but not, usually, arteriosclerosis in the cochlear vessels. These are cases of senile deafness, which is probably a normal process of advancing age.

But in the second group deafness started in the early forties, and nothing was found which so much as suggested any ætiological factor. It is this group of cases, characterized by a high-tone deafness of early onset with an abrupt fall in high tones, which is of particular interest to us clinically. In the absence of any other possible cause we are compelled to consider some change in the endolymph, and it seems to me that the most probable cause of that change is some toxic influence, either blood-borne or via the middle ear. The action of toxins by the blood-stream is well known; the work of Taylor on quinine is of particular interest, as he has brought forward a great deal of evidence to show that quinine medication of the pregnant woman can produce congenital deafness in the child; we must remember in this connexion that quinine is now widely used not only in the treatment of malaria but also as a means of accelerating labour, legitimately or otherwise. Wittmaack has found that in dogs,

as we know clinically in man, there are individual idiosyncrasies to quinine. In sensitive subjects there seems to be a double action ; a fall of the intralabyrinthine pressure with collapse of Reissner's membrane, and changes in the ganglion cells.

Wittmaack believes that two factors are at work—a specific toxic action on the nerve elements, and a protective ischæmia which limits the attack of the poison but at the same time lowers the intralabyrinthine pressure.

Other drugs which cause internal-ear deafness are salicylates, arsenic, the vapour of benzine, and tobacco. Carroll and Ireland have recently reported cases of " island deafness " associated with tobacco-alcohol amblyopia.

But interesting and important as these conditions are, I believe that from our point of view, of all the blood-borne toxins the most important are the endogenous, the toxins produced by focal lesion elsewhere. Here let me admit at once that we are on slippery ground. We can argue only by clinical observations ; histological and experimental proof are lacking. In support of this view I will refer to Mr. A. J. Wright's recent paper on Ménière's syndrome, in which he suggested that many cases of this condition are due to a serous labyrinthitis secondary to focal infection elsewhere ; further, you will remember, in support of this hypothesis, he found that elimination of such septic foci usually cured the condition. In internal-ear deafness I believe a similar, but milder condition, often exists. Unfortunately adequate clinical evidence is difficult to produce. In many cases of internal-ear deafness we find evidence of focal sepsis. When this is cured in some cases the hearing is remarkably improved ; in the majority it remains unchanged ; it does not improve, beyond the improvement which we notice with the improvement of general health in any deafness, and it does not get worse. As to the failure of improvement perhaps the damage is already done ; to alter a little the words of the poet—" the evil that teeth do lives after them " ; as to the arrest in the process, we must remember that in the majority of cases internal-ear deafness advances slowly and often remains stationary for years, so we cannot fairly build too much on that. Nevertheless, I am convinced that along this line is our best hope of progress. I should like to say at once that I do not advocate chop-it-and-chance-it surgery ; I do not think that every patient who falls into our hands with internal-ear deafness should leave us minus teeth and tonsils, with every sinus drained and portions of his intestinal tract ablated, but I do say that all these things should be investigated, especially those regions which lie beyond our ken, his appendix, his gall-bladder, and his prostate. Attacks on the accessory sinuses have usually disappointed me, and the more I hear of intestinal stasis as a cause of deafness the less I believe in it. Occasionally we see a patient whose hearing improves after a course of intestinal lavage, but in my experience they are rare. We must remember that anything which improves a patient's general condition diminishes his liability to fatigue, mental and physical, and so increases his power of attention. He does not really hear better, he only listens better.

In the acute specific fevers, especially in scarlet fever and mumps, we have cases of internal-ear deafness either blood-borne or by the perilymph. It is not uncommon to find cases where internal-ear deafness was first noticed after pneumonia or influenza.

Internal-ear deafness due to syphilis is, I believe, a diminishing problem ; I have found only four cases in the last two years, all of them congenital, and it was not for lack of looking for them. In the time at my disposal I shall deal very briefly with this condition. It is generally agreed that in congenital syphilis the injury is to the cochlea, and the work of Fraser and Mayer has shown that the typical lesion is a gummatous osteo-periostitis, with secondary changes in the cavities. Such a multiplicity of possible lesions can well account for the protean manifestations of the condition. In acquired syphilis the lesion is either a neuro-meningitis, primarily affecting the nerve-trunk, or else a gumma, which can occur anywhere. Uncommon though syphilitic deafness may be, it must never be forgotten ; especially in cases of sudden deafness of the internal-ear type in young adults.

So much for invasion from within ; next we must consider invasion from without. We have all seen examples of this, particularly in cases of pneumococcal infections when, although we have achieved an excellent surgical result with a healed ear and an intact static labyrinth, the patient is left with an internal-ear deafness of varying, sometimes considerable, severity. I would suggest that these cases are far more common than we realize. I have been struck by the frequency with which patients who come to me in middle life with internal-ear deafness give a history of acute aural infections in boyhood. In such cases all that can be seen is a scar on the membrane, the tube is patent, membrane and ossicles are mobile, and there is no sign of middle-ear deafness. It is difficult to explain, if this view is correct, why the deafness is not appreciable until middle life. It may be that by then the patient has had ample opportunity for damaging his ears by tobacco and the strain of noise ; it may be that the original damage has started a slow degenerative process.

Noise is a factor which we must never forget. The researches of our colleague Mr. Ritchie Rodger and developed by Wittmaack, Yoshido, von Eicken, and more recently by Temkin, have proved conclusively that long-continued noise can damage the organ of Corti. From this proved fact we are entitled to regard the continued uproar of our streets as a danger to hearing, especially to hearing already damaged. The damage done by sudden noises or concussions of the ear without fracture of the labyrinth has been questioned. I have two cases in one of which deafness followed a blow on the ear from a book, and had lasted, when I saw the patient, thirty-odd years, and another of similar duration followed a blow in a boxing competition. In neither case was there any loss of labyrinth function, and I would suggest that this may be due to two causes—the action of the utriculo-endolymphatic valve, and the fact that the older function has the higher power of survival. Just as in the larynx adduction survives abduction, so in the ear the vestibular labyrinth has a greater power of survival than that parvenu of the special senses, the organ of Corti.

Treatment.—If we can find a cause our problem is simple. The most likely cause is a septic focus and, if possible, it must be eliminated. Dental sepsis is the most hopeful, and of all dental sepsis that due to an impacted wisdom tooth or a crowned stump is the most likely to repay our efforts. Tonsillar sepsis comes a bad second. Accessory sinusitis, unless there is definite retention of pus, does not seem to be a common cause. Abdominal foci I have already mentioned.

Faradism and the various forms of vibro-massage are much used on the Continent, and some patients certainly claim considerable benefit from them. Personally I am rather sceptical of their value except as increasing local blood supply, and I feel that the greatest caution should be exercised in their use.

Protection from noise is important, and I have found protectors and soft plugs most useful.

The physicians can often help us with the patient's general health, and with his vascular condition if arteriosclerosis is present ; but very often I find that the patient hears better when his blood-pressure is a little up rather than too much down.

Recently some encouraging results have been reported from the use of vitamin B in large doses, but the work is still too new for criticism.

In these cases the modern development of the valve-hearing aid, properly and carefully adapted to the need of the individual, is often of the greatest help.

Lastly, in every case of internal-ear deafness we must remember that the most trivial and transitory additional middle-ear deafness adds disproportionately to the patient's discomfort.

Mr. Suggit showed a number of audiograms representing different types of internal-ear deafness, of which the following are a selection. These audiograms were made with the Western Electric 2 B E audiometer in the Silence Room at University College Hospital.

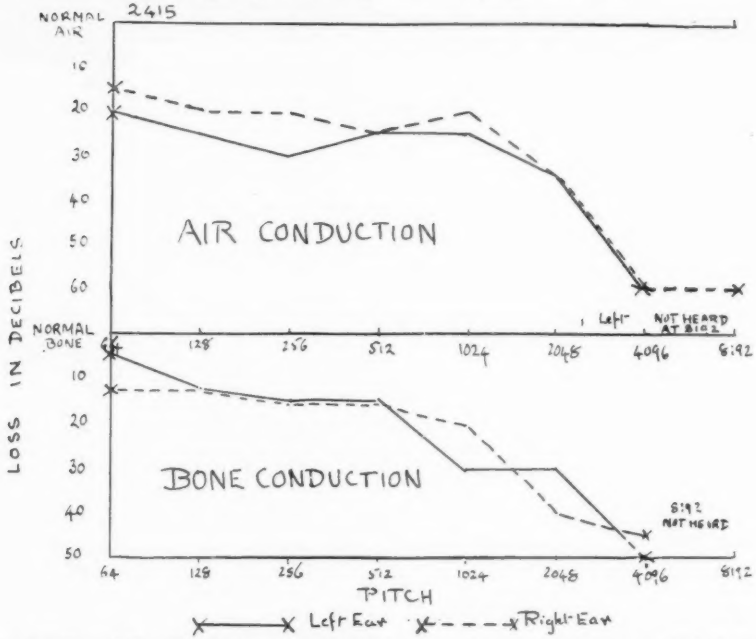


FIG. 1.—Man of 70 with a history of slight deafness for three to four years, particularly when someone is talking at a distance. No tinnitus, no familial deafness, normal drums, and a positive Rinne test. This illustrates a characteristic internal-ear deafness curve, with a marked falling off in the hearing of the upper tones, and approximately equal loss by air and by bone conduction.

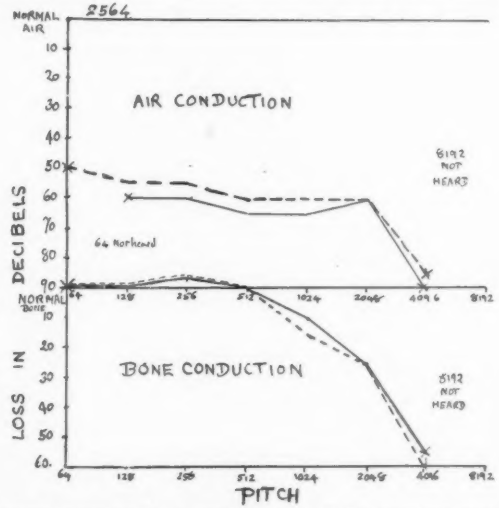


FIG. 2.—An advanced otosclerosis; a good contrast to the previous case. Woman of 39 with three to four years' history of deafness, severe tinnitus, and paracusis, no familial deafness, normal drums, and a negative Rinne test up to 1,024 d.v., becoming positive at 2,048 d.v. The radiograph shows definite blurring of the left labyrinthine capsule, and doubtful blurring of the right capsule. The hearing for the upper tones is much diminished, similar to an internal-ear deafness, but the bone conduction remains normal in the lower tones in contrast to a marked air-conduction loss.

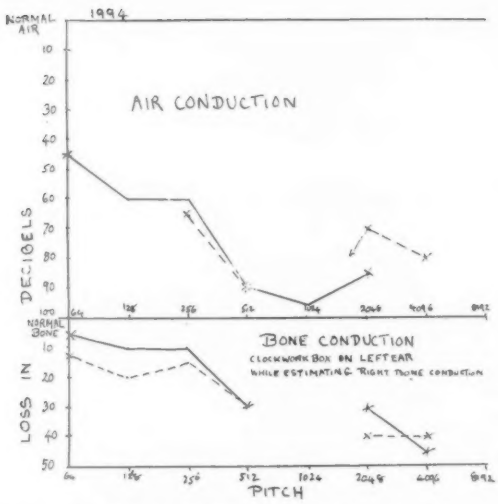


FIG. 3.—A woman of 38 with deafness in the right ear since the age of 12, and in the left ear since the age of 17; paracusis and tinnitus. She illustrates the patch type of loss in advanced otosclerosis. Sister, mother and grandmother deaf.

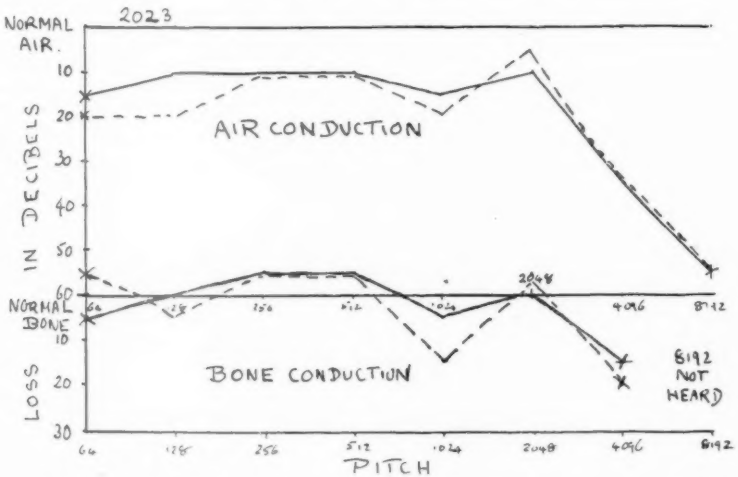


FIG. 4.—A man of 60 with a history of attacks of vertigo for seven years. Many audiograms in Ménière's syndrome tend to give the characteristic picture of internal-ear deafness. Others show loss both in the upper and lower tones (fig. 5).

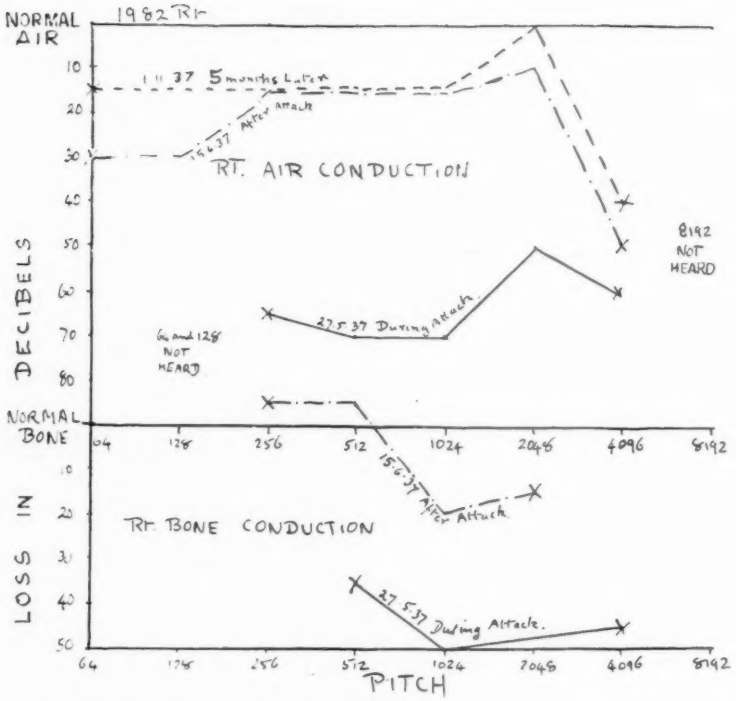


FIG. 5.—The hearing of the right ear of a man of 54 who had been deaf in the left ear for thirty-three years and in the right not so long. During this time he had always had attacks at varying intervals of vertigo and falling to the right. He had a bad attack six days previously and on examination he had practically no useful hearing for ordinary conversation. He was put to bed on a sodium-free diet and ammonium chloride. Three weeks later his hearing showed a very great improvement, not only in level, but in range in the lower tones. Audiograms taken five months later, 1.11.37, showed still further improvement.

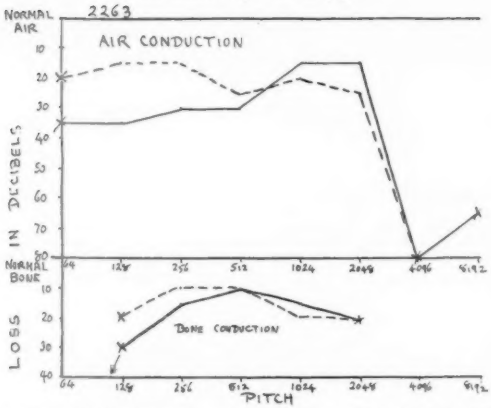


FIG. 6.—A man of 48 who was under the care of Dr. F. M. R. Walshe with syphilitic meningomyelitis; positive blood and cerebrospinal fluid Wassermann reactions, and typical luetic colloidal gold curve. He had been deaf some months and had had minor attacks of vertigo with tendency to fall to the right. There was no middle-ear disease. It would appear that this case is a lesion of the 8th nerve.

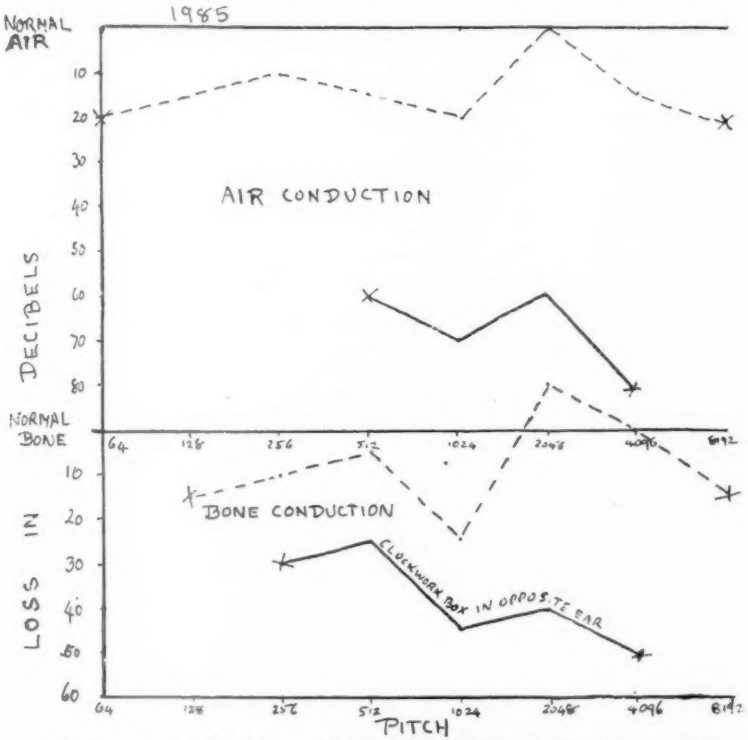


FIG. 7.—A man of 36 who had a left deafness and tinnitus following mumps five weeks previously. The hearing of the right ear is normal, but the left shows considerable loss with a residual patch of hearing between 512 and 4,096 d.v.

The Electrical Activity of a Denervated Ear[1]

By A. F. Rawdon-Smith, M.A., Ph.D. (University of Cambridge), and J. E. Hawkins, Jr., B.A. (Harvard Medical School)[2]

Abstract.—The electrical response from the cochlea of a cat which had previously been denervated by intracranial crushing of the auditory nerve was submitted to a lengthy study, the results of which may be summarized as follows :—

The responses to acoustical stimulation derived from electrodes placed on the round window margin and in the chin muscles were studied by means of an amplifier and cathode ray oscillograph, in the usual way. Transient stimuli whose polarity could be reversed were employed to demonstrate the absence of any electrical component of neural origin such as is invariably present in a normal ear. In all other respects, however, the responses were unaffected, and both threshold contours (the so-called "electrical audiogram") and equal response contours for approximately pure-tone stimuli demonstrated close comparability with those for normal ears. Harmonic analysis of the cochlear response yielded results departing from the normal only in such respects as would be expected in view of the complete absence of nervous component in the analysed wave.

From these data, it is argued that this animal presented a case in which normal electrical responses were obtained from the peripheral organ, despite virtually complete degeneration of the auditory nerve, and, it follows, complete unilateral deafness. Subsequent histological examination confirmed these observations, and it is urged, therefore, that the validity of the view that the cochlear response provides an index of the hearing ability of an animal, as is sometimes stated, is open to question. Additionally, this experiment finally discredits the hypothesis that the cochlear response itself is, in any sense, neural in origin; it further indicates the necessity for caution in the interpretation of results obtained from normal ears, where the cochlear response, however derived, is in some degree adulterated by the simultaneous presence of an action potential component.

Résumé.—La réaction à la stimulation électrique de la cochlée d'un chat chez lequel la partie intracranienne du nerf auditoire avait été écrasée fut soumise à une étude prolongée qui a donné les résultats suivants.

Les réactions aux stimulations auditoires obtenues aux moyen d'électrodes au bord de la fenêtre ronde et dans les muscles du menton furent étudiées au moyen d'un amplifieur et d'un oscillographe cathodique par la méthode ordinaire. Des stimuli passagers à polarité réversible furent employés pour démontrer l'absence de toute constituante électrique d'origine nerveuse, comme il en existe toujours dans l'oreille normale. A part ceci, toutefois, les réactions sont restées normales, et la courbe de seuils (l'"audiogramme électrique") ainsi que la courbe de réaction égale à des stimuli de ton à peu près pur ressemblent de près à celles données par des oreilles normales. Les résultats de l'analyse harmonique de la réaction cochléaire diffèrent des résultats normaux seulement par l'absence complète de la constituante nerveuse dans la courbe analysée.

Il est conclu que dans cet animal une réaction normale de l'organe périphérique fut obtenue en dépit de la dégénération à peu près complète du nerf auditoire, et, par conséquent, une surdité unilatérale complète.

Un examen histologique confirma ces observations, et les auteurs insistent donc que l'opinion exprimée quelquefois, que la réaction cochléaire donne un index du pouvoir auditoire de l'animal, peut être mise en question. De plus, cette expérience réfute l'hypothèse que la réaction cochléaire est d'origine nerveuse. Elle démontre aussi la nécessité d'une certaine prudence dans l'interprétation des résultats obtenus dans des oreilles normales, où la réaction cochléaire, quelle qu soit son origine, est modifiée à uncertain degré par la présence d'un constituant potentiel d'action.

[1] Paper read in substance before the Otological Section of the Royal Society of Medicine, December 2, 1938.

[2] The work described in this paper was performed in the Department of Physiology, Harvard Medical School, during the tenure by one of us (A. F. R.-S.) of a Rockefeller Foundation Fellowship.

ZUSAMMENFASSUNG.—In Versuchen an Katzen wurde die elektrische Reaktion der Cochlea nach vorheriger intrakranieller Zerstörung des N. acusticus eingehend untersucht. Zusammenfassend kann über die Resultate folgendes gesagt werden :

Die elektrische Reaktion auf akustische Reizung wurde in der üblichen Weise mittels Ableitungselektroden am Rand des runden Fensters und an der Kinnmuskulatur mittels Vertärkers und Kathodenstrahloscillographen untersucht. Es wurde kurzdauernde Reizung mit umkehrbarer Polarität verwendet, um zu zeigen, dass keinerlei neurogene elektrische Komponenten vorhanden waren, wie man sie am normalen Ohr immer findet. Abgesehen hiervon waren aber die elektrischen Reaktionen unverändert, und sowohl die Verbindungslinie der Schwellenwerte (das sogen. " elektrische Audiogramm ") als auch die Verbindungslinie gleichstarker Reaktionen kontour für Reize mit annähernd reinen Tönen zeigten strenge Vergleichbarkeit mit denen des normalen Ohres. Die harmonische Analyse der Reaktionskurve der Cochlea ergab Resultate, die nur insoweit von der Norm abwichen, wie man es angesichts des vollkommenen Fehlens nervöser Komponenten in der analysierten Kurve erwarten musste.

Aus diesen Befunden wird geschlossen, dass dieses Versuchstier einen Fall darstellt, in dem normale elektrische Reaktionskurven vom peripheren Organ aus registriert wurden, obwohl der N. acusticus praktisch vollkommen degeneriert war, was zu völliger einseitiger Ertaubung geführt haben musste. Die anschliessende histologische Untersuchung bestätigte diese Beobachtungen, und es wird deshalb bezweifelt, ob die elektrische Reaktion der Cochlea einen Massstab zur Beurteilung des Hörvermögens von Tieren darstellt, eine Ansicht, die man zuweilen vertreten findet. Ausserdem widerlegt dieser Versuch endgültig die Hypothese, dass die Reaktion der Cochlea als solche neurogenen Ursprunges ist ; ferner mahnt das Resultat dieses Versuches zur Vorsicht in der Interpretation von an normalen Ohren gewonnenen Ergebnissen, wo die Reaktion der Cochlea—auf welche Weise sie auch erhalten sein möge—bis zu einem gewissen Grade durch das gleichzeitige Bestehen einer Aktionspotentialkomponente gefälscht ist.

Introduction.—Since 1930 the literature of otology has contained increasingly numerous references to the so-called " Wever and Bray Effect ". This curious phenomenon, which was discovered in the previous year, excited considerable attention immediately it was reported (Wever and Bray, 1930*a* and *b*), and has been the subject of much investigation since that time (for summary of this work, *see* Rawdon-Smith, 1939). Indeed it is no exaggeration to say that Wever and Bray's discovery has stimulated more research in the auditory sphere than has any other single factor before or since, whilst its study has, moreover, already contributed significantly to our understanding of the peripheral sections of the auditory mechanism.

Apparatus.—The essential details of the apparatus necessary for studying the electrical phenomena of the ear have been too often described for a detailed account of these to be necessary here. The equipment may be conveniently divided into that required for stimulating the auditory mechanism and that necessary for the amplification and recording of the electrical output from the cochlea or 8th nerve. The stimulating device conventionally used consists of a source of sinusoidal alternating current, controllable as to frequency and magnitude, together with a loud-speaker with which this may be converted into a pure tone; while the recording system usually comprises a thermionic vacuum tube amplifier of controllable gain, an oscillograph, and a second loud-speaker. To the input of the amplifier the recording electrodes are connected, and these are placed, when recording cochlear potentials, on the margin of the *fenestra rotunda* and on an indifferent point near the ear. To this equipment we have added, in the present experiments, a transient stimulating device similar to that described by Derbyshire and Davis (1935), and a wave-analyser.[1] By means of the latter the harmonic content both of the stimulus and of the cochlear response could be studied most conveniently.

Response from a normal ear.—Where a normal animal is employed as a preparation,

[1] For the loan, at very short notice, of this instrument (General Radio, Type 636–A) the authors are deeply indebted to the General Radio Company, Cambridge, Massachusetts.

and with electrodes disposed in the manner outlined above, the voltages derived from these arise from two sources (Davis, Derbyshire, Lurie and Saul, 1934). The greater fraction comes from within the cochlea, from some structure vibrating in response to the applied stimulus—though its precise origin has been a cause for some dispute (for summaries, *vide*, e.g. Hallpike and Rawdon-Smith, 1937 ; Rawdon-Smith, 1938 ; and Stevens and Davis, 1938). Adulterating this so-called *cochlear component* is a second form of response, due to the passage of synchronized impulses in the auditory nerve, and therefore termed the *action potential component*. The latter appears as distortion on the oscillogram of the electrical output derived in the manner described, distortion, moreover, which varies both in nature and in extent with the frequency of the applied stimulus. This fact has somewhat seriously limited the applicability of the technique under discussion to the study of certain auditory phenomena, for it is clear that the combined electrical wave obtained from a normal cochlea cannot reflect a true picture of the wave-form of the vibration of any structure within, since certain harmonic constituents appear from an extraneous source, in the form of the action potential component. In the present paper we shall describe the electrical response of a cochlea which had been previously denervated, and which did not, therefore, suffer from this limitation.

Preparation.—In this work a cat was used in which the 8th nerve had been crushed intracranially five weeks earlier than the date on which the electrical studies were made. It has been suspected for some time that, provided concomitant severance of the internal auditory artery is avoided, section of the trunk of the 8th nerve in this animal results, *inter alia*, in the production of widespread degeneration of the ganglion cells and nerve-fibres of the cochlear neurones *peripheral* to the point of section. This striking effect, which is clearly contrary to the classical laws of Wallerian degeneration, is now very well attested (for summary of this evidence, *see* Hallpike and Rawdon-Smith, 1934*a*), and it has been used in the present work to enable a study to be made of the cochlear microphonic effect, unadulterated by the action potential component unavoidable in a normal ear. Previous work (Ashcroft, Hallpike and Rawdon-Smith, 1937) indicated that five weeks is a suitable time during which to allow degeneration to proceed ; few normally appearing neural elements persist in an average animal after this time, whilst complications of various kinds which may ensue thereafter can then be avoided. It will be shown that these predictions are well borne out in the present instance

Technique employed in the present investigation.—It is clearly possible, with the apparatus which has been briefly described above, to gather data in regard to the intensity at which a pure tone stimulus must be applied to an animal's ear for the resultant electrical response to be just detectable. Moreover this procedure may be repeated for stimuli of any frequency within the limits of the apparatus, which for equipment of good characteristics will be from approximately 50–10,000 c.p.s. Many academic objections may be levied against the use of curves produced in this way for comparative purposes, since both the absolute and the relative values realized will be to a great extent dependent upon the measuring equipment employed rather than upon the ear under test. To some extent these difficulties are met by the observation that what may best be termed the " resolving power " of any equipment of adequate gain will be determined by the masking effect of the thermal noise in the input circuit, i.e. across the preparation. This will be dependent mainly upon the impedance between the electrodes, which will, from preparation to preparation, be reasonably constant. Consequently, provided that the response curve of the amplifier used is flat over the range of response frequencies investigated, results may be obtained which reflect the acoustico-electric transducing efficiency of any given ear. To the curves thus produced, the name " electrical audiogram " has been applied, notably by Davis (1935) and, in view of their general adoption by him and his collaborators, it was thought advisable that our denervated ear should be tested in this way, in order

to permit a comparison of the sensitivity of this ear with that of the normal cat. It must be emphasized, however, that the cochlear phenomenon shows no true " threshold " whatsoever.

The objections to the " electrical audiogram " technique outlined above, and certain others not mentioned, may be met without difficulty if, instead of a " just noticeable " electrical response, a response of small but definite magnitude is employed as the criterion. For this reason, in our present work arrangements were made whereby a known sinusoidal voltage, of frequency identical with that of the stimulus falling upon the ear, could be injected into the amplifier input circuit effectively in series with the preparation. Observation (on the cathode ray oscillograph) on the one hand of the figure yielded by this calibrating voltage, and on the other of that produced by the response from the cochlea itself, enabled the stimulus intensity to be adjusted until the latter reached a predetermined value. This procedure, which has numerous theoretical advantages over the " electrical audiogram " technique, allowed us to establish " constant response curves " similar to those derived, for example, by Wever and Bray (1938), though our technique departed in many details from theirs. For example, in the present work the stimulus was conducted to the ear of the preparation by means of a thick-walled rubber tube, whilst in theirs free air-borne sounds were employed. Our technique has, we believe, the minor advantage of avoiding difficulties owing to the shadow effect of the pinna at high frequencies, though the problem of absolute intensity calibration of the sound source, essential in this type of investigation, is simultaneously rendered more difficult of solution. In the present instance, however, the latter difficulty was overcome, with fair success by means of a suitable microphone.

Response to pure-tone stimuli.—The " electrical audiogram " and constant response curves discussed in the preceding paragraph were found to be, for the ear under discussion, virtually indistinguishable from those of normal ears tested under identical conditions. Threshold, 4 μV, 40 μV, and 400 μV contours are shown in fig. 1, and from these it may be seen that the only significant departure from normality rests in the somewhat greater smoothness of all curves, more particularly in the 700 c.p.s. region, than is found for the normal ear. This effect is well illustrated by fig. 2, in which the audiogram of this ear is plotted together with the average curve for eight normal ears given by Derbyshire and Davis (1935, fig. 5B, p. 484). Both curves have, in this case, been corrected for the characteristics of the sound system employed and are thus strictly comparable. Their close similarity may be seen from this figure, though the slight departure between 300 and 1,500 c.p.s., combined with the absence of any abrupt upward trend at 700 c.p.s., is we think, of some significance ; our interpretation of these effects may be briefly outlined as follows.

The often extreme irregularity of wave-form of the output from a normal ear over this frequency range indicates the presence in such a response of a marked action-potential component. Careful observation convinces us that this component is approximately in phase with the cochlear potential below 500 c.p.s., whilst immediately above this the phase shifts sharply, to produce the cancelling effect shown at or near 700 c.p.s. The phase shift, which necessarily continues as the stimulus frequency is raised after this, throws the two responses once more into reinforcement at approximately 1,000 c.p.s., though the nervous component reinforcing any given cochlear response wave is now that due to the *preceding* wave of the stimulus, as would be predicted. Above 1,000 c.p.s. synchrony of the nervous discharge breaks down, and these phenomena are no longer of importance in either the normal or the denervated preparation. We cannot, therefore, readily account for the sudden drop of sensitivity of the normal ear at 2,500 c.p.s. in a similar way, and this we tentatively ascribe to an antiresonant dip in the response curve of the stimulating equipment employed by Derbyshire and Davis. No similar effect was found on the apparatus employed by ourselves for the normal ear, though the alternate reinforcement and

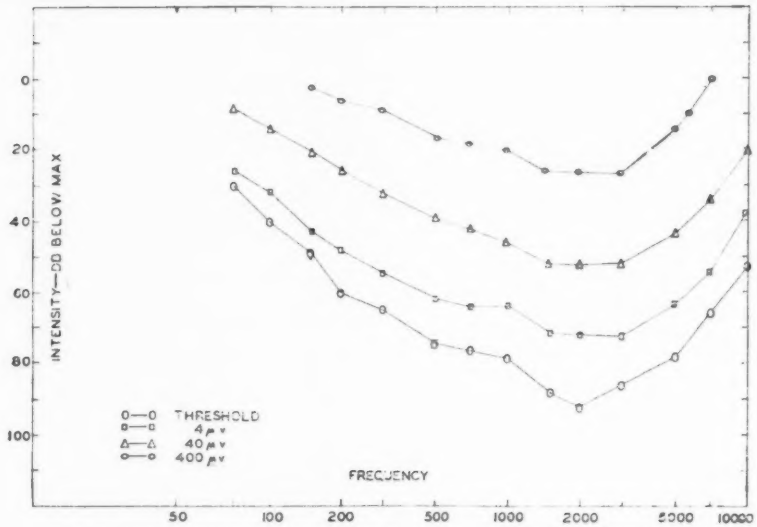


FIG. 1.—The " Electrical Audiogram ", together with three Equal Response Contours, for a denervated cochlea. The Equal Response Contours show the intensity of a pure-tone stimulus required to elicit a constant response of 4, 40, and 400 μ V peak, and were obtained by injecting a calibrating voltage effectively in series with the preparation. The curves are not corrected for the characteristics of the sound system employed.

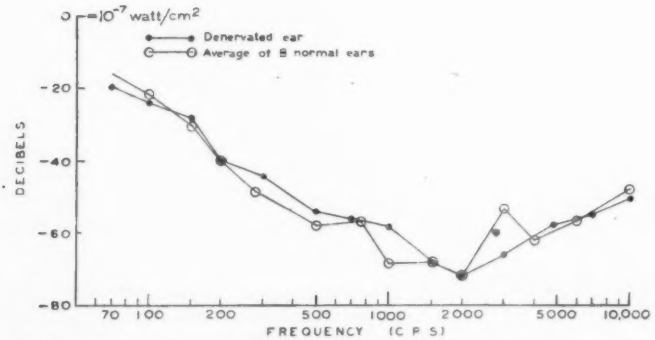


FIG. 2.—The " Electrical Audiogram " of a denervated ear, compared with the average curve (from Derbyshire and Davis, 1935) for eight normal ears. Both curves are corrected for the characteristics of the sound stimulating system.

cancellation phenomenon discussed above was very well marked. We feel justified, therefore, in neglecting the second departure of the two curves until more evidence is to hand, and conclude that, save for such minor deviations as would be predicted from the absence of an active nerve component, the threshold curves for this animal were virtually identical with those of a normal preparation.

Fig. 1 shows that the equal response contours taken demonstrate a similarly close comparison, and it may seem worthy of record that the maximum voltages which this cochlea would generate were also closely similar to those present in normality. By every available test, therefore, the acoustico-electric sensitivity of our preparation was distinguishable from normal only in such minor ways as would be expected.

Response to transient stimuli.—Derbyshire and Davis (1935) have shown that the application to the mammalian ear of a transient stimulus (such as that produced by

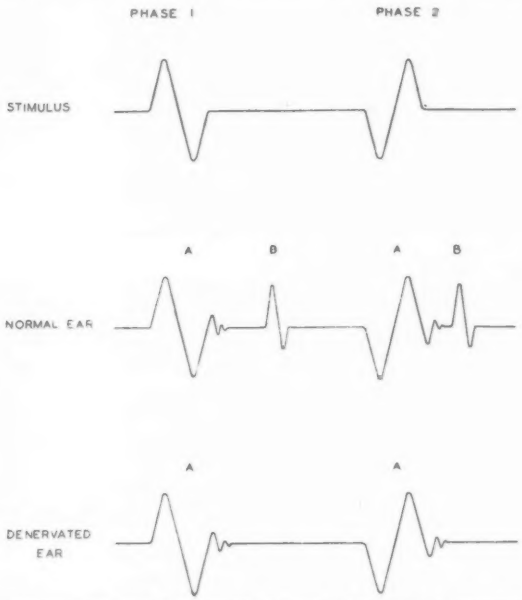


FIG. 3.—Diagram to show the essential details of the transient response of normal and denervated ears. In response to a stimulus such as that shown, the normal response comprises two wave trains : A, that arising in the intracochlear structures, and B, an action potential component. The polarity of the former is reversed when the phase of the stimulus is changed through 180°, as is shown on passing from Phase 1 to Phase 2, whilst the latter, save for a change in latency, is not modified. The response from the denervated ear shows no action potential component, and thus all waves change polarity on changing from Phase 1 to Phase 2.

sending a brief condenser discharge through a loud-speaker) yields, from a normal cochlea, two distinct responses. The earlier complex represents the cochlea response proper, and, following this, a second wave or train of waves appears, which they identified as action potentials. This differentiation they made on several grounds, notably that on reversing the polarity of the stimulus, the polarity of the first wave train was reversed, whilst that of the second remained unaltered. Moreover, the two responses exhibited quite dissimilar susceptibility to masking by a "hissing" sound, in that the first was virtually unaffected whilst the latter was reduced or even

removed. These phenomena, whose existence in the normal ear we have fully confirmed, provide a useful and unequivocal indication of the presence or absence of functional nervous elements within the cochlea, and both techniques were employed by ourselves in the present investigation.

The first consisted in the application to the ear of a train of transient stimuli derived from a gas-discharge tube oscillator whose output passed to the speaker employed in the earlier investigation of the response to pure tones. Both this oscillator and the linear sweep employed with the cathode-ray tube on which the response was observed could readily be synchronized to an independent source of alternating voltage. In this way the response waves appeared stationary on the tube face, and could be inspected with great ease.

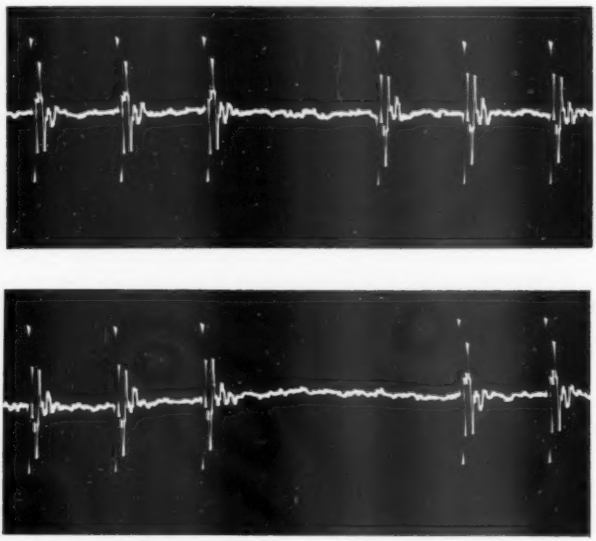


FIG. 4.—Cathode ray oscillograms of the cochlear response to a train of transient stimuli applied at a rate of 60 per second to the denervated ear. The polarity of the stimulus is reversed at the gap in each record, and this produces complete reversal of the polarity of the response. No action potential component is, therefore, present.

Our first finding is illustrated diagrammatically in fig. 3, and may be briefly described as a failure to discover any component in the transient response of this ear, the polarity of which was independent of that of the stimulus. This held true, irrespective of the intensity of the transient stimulus, and cathode-ray oscillograms of the response to a train of stimuli of high intensity are shown in fig. 4. From this it will be seen that the actual response obtainable from the ear to transient stimuli of the type described is somewhat more complex than that shown diagrammatically in fig. 3; careful inspection of fig. 4, however, will reveal no component in the response whose polarity is not reversed at the point marked.

The application of an additional "hissing" stimulus evoked virtually no change in this response whatsoever, and we feel justified in concluding, therefore, that at best very few functional nervous elements remained in the ear under discussion. That this view was adequately confirmed by subsequent histological study will be shown later.

Harmonic analysis of the cochlear response.—Two separate investigations of the harmonic content of the normal cochlear response have been reported (Newman, Stevens and Davis, 1937 ; Wever and Bray, 1938). In both these papers indications are given that their authors are aware of the fact that the presence, in the electrical output from the cochlea, of an action potential component will modify the results obtained. In particular, the even harmonic content of the output, more particularly the second harmonic, would be expected, in a normal ear, to be greater than would that of the cochlear response alone. Confirmation of these views was obtained in the present case, as may be seen by inspection of fig. 5, in which the amplitude of the fundamental and first four harmonics in the response to a pure tone stimulus of frequency 1,000 c.p.s. is plotted against stimulus intensity. To facilitate comparison of these curves with those of the earlier workers, the first three curves are replotted in fig. 6, together with those of Newman, Stevens and Davis (*loc. cit.*, fig. 2, p. 108). It will be noted that the fundamental curves in the two cases are strikingly similar,

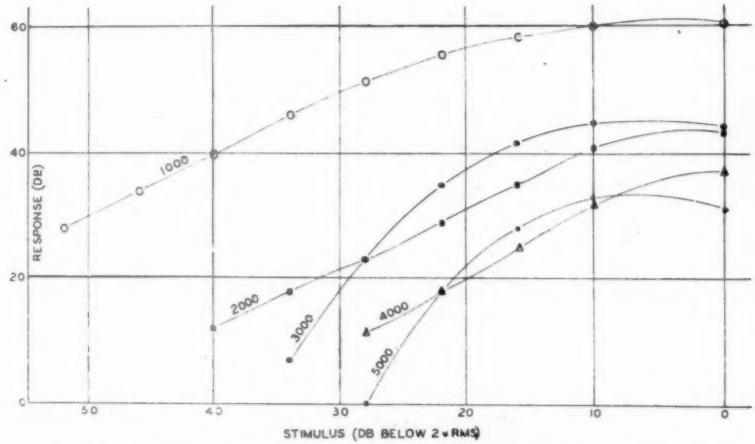


FIG. 5.—Curves connecting the magnitude of the fundamental and the first four harmonics in the cochlear response with the intensity of an essentially pure-tone stimulus. These data are for a denervated cochlea, and for a stimulus frequency of 1,000 c.p.s. Note that both scales are logarithmic, the stimulus scale referring to an arbitrary maximum corresponding to 2 volts R.M.S. at the output of an attenuator preceding the loud-speaker.

though the denervated animal shows, over the low range of stimulating intensities, considerably less second harmonic content than does the normal. The marked turnover at high stimulating levels shown in the second harmonic curve for the normal ear is, however, virtually absent in our preparation ; thus at the highest levels the output from the normal ear contains *less* distortion of this type than does the denervated. This interesting effect we tentatively interpret as indicating that the turnover in the normal curve is due to increased contraction of the *tensor tympani* and *stapedius* muscles which, by increasing the stiffness of the ossicular chain, tend to lessen the distortion introduced by this transmission mechanism. This observation confirms the previous tentative one of Hallpike and Rawdon-Smith (1934*b*), who stated that contraction of these muscles appeared to reduce the harmonic present in the cochlear output. This latter statement is also made by Newman, Stevens and Davis (*loc. cit*) ; Wever and Bray (1938), however, have apparently arrived at the conclusion that the harmonic content of the cochlear output is not modified by the muscles in question,

and is not, in their opinion, introduced by the middle-ear mechanism. Our own observations, whilst not conclusive on this point, would apparently favour the earlier view, in that this animal, in which no action potential component could be detected and whose middle-ear muscles were for obvious reasons inactive in response to sound, showed no turnover of the second harmonic curve comparable with that reported by Wever and Bray themselves, or by Newman, Stevens and Davis.

Though one would not wish to base more than tentative quantitative conclusions on the evidence at present available, it would appear from the second pair of curves of

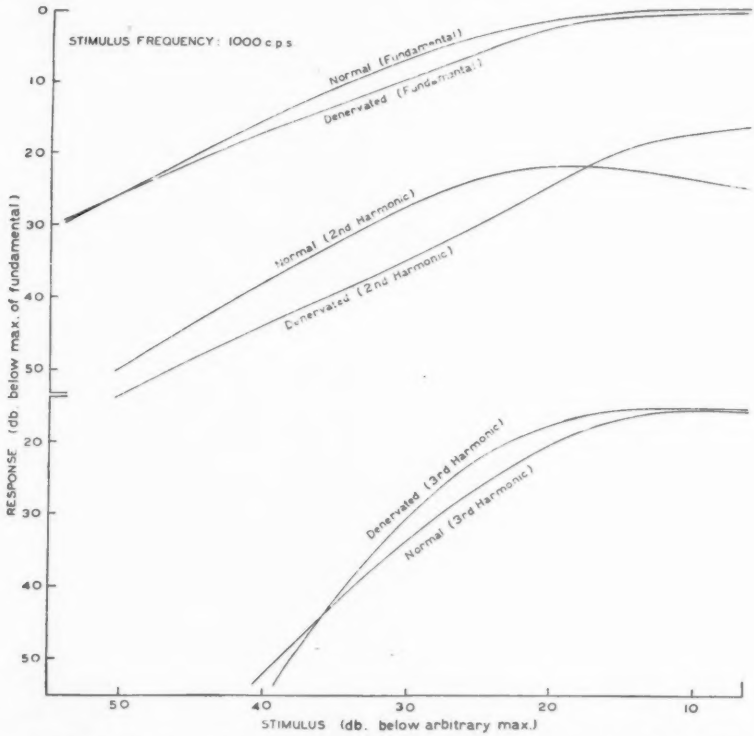


FIG. 6.—The fundamental, second, and third, harmonic curves of fig. 5 replotted together with those of Newman, Stevens and Davis (1937) for a normal ear. The latter should be compared with those for the denervated cochlea.

fig. 6 that, even for stimulating frequencies as high as 1,000 c.p.s., as much as 60% of the second harmonic measured in the response of a normal ear is due to the presence, in this, of a synchronous nervous component.

It would be expected that the odd harmonic constituents of the cochlear output would be little affected by the absence of nervous response, and this conclusion is well borne out by the third pair of curves of fig. 6. Inspection of these reveals, indeed, that the third harmonic content of the denervated cochlear response was, if anything, greater than that of the normal ear. We are not, however, inclined to regard this

difference as reflecting more than an innate difference between the auditory mechanisms of two dissimilar preparations.

Considerable difficulty has attached in the past to an investigation of the harmonic content of the response of a normal ear to stimuli of lower frequency than 1,000 c.p.s., owing to the fact that the action potential distortion present is far greater for low stimulating frequencies than for high, as would be expected. For this reason, an opportunity was sought in the present case to investigate the response to lower frequency stimuli, and the results for a stimulating frequency of 200 c.p.s. are shown in fig. 7. It will be seen that the second harmonic present is quite small, and that it rises in a somewhat irregular manner as the stimulus intensity is raised. For the

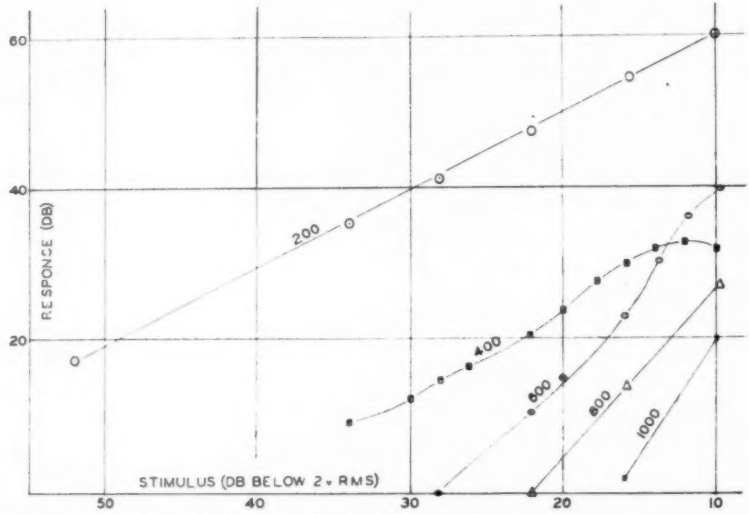


FIG. 7.—Curves similar to those of fig. 5, but for a lower stimulating frequency (200 c.p.s.). Note the low second harmonic content, due to the absence of an action potential component, despite the low stimulating frequency.

resulting curious shape of this curve we have, at the present time, no explanation, though the phenomenon would seem to be of some interest.

Histological observations.—The results of post-mortem microscopic inspection of this ear, a section of one whorl of which is shown in fig. 8, may be briefly summarized as follows. The spiral ganglion showed marked degeneration throughout, though a few more normally appearing cells were observable near the helicotrema than in the first and second turns. The cochlear nerve showed well-marked degeneration, with few normal fibres persisting. Fibres passing from the ganglion to the organ of Corti were mainly degenerate. The organ of Corti itself, however, presented an appearance virtually indistinguishable from the normal. Slight hæmorrhage was present in the last third of the second turn, and near the helicotrema. Reissner's membrane was ruptured in the middle of the second turn, though in view of the somewhat imperfect fixation of this preparation much importance cannot, it is believed, be attached to this.

These results would appear to bear out the contention that this ear was virtually normal save for an absence of functional nervous connexions.

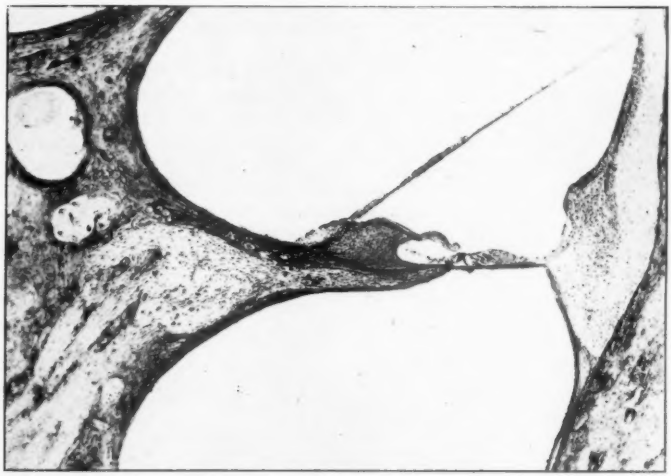


FIG. 8.—Section through the basal turn of the cochlea of the cat studied in this work. Note the degenerate appearance of the spiral ganglion, with very few normal appearing cells remaining; the nerve-fibres from ganglion to organ of Corti may be also seen to be mainly degenerate. The organ of Corti itself appears normal in all observable respects.

Conclusions.—It is clear from the data given above that this animal had been rendered, by the previous operation in which the auditory nerve was crushed intracranially, deaf in one ear. Evidence, both histological and otherwise, indicates that the artery had escaped simultaneous severance, since the complete necrosis associated with this event (*vide*, Hallpike and Rawdon-Smith, 1934*a*) was not present; in certain other cases of the series to which this animal belonged, moreover, such disintegration was well marked. Despite an absence of observable functional nervous elements, however, in every way measured the electrical response of this ear was normal, save in such minor respects as could be explained from the fact that no action potential component was present. It would appear, therefore, that a literal interpretation of the statement that the cochlear response provides an index of an animal's hearing ability, which is not infrequently made, is quite impossible. It is clear, moreover, that this evidence finally disposes of the view that the cochlear response is, in any sense, neural in origin.

It appears additionally worthy of note that the results of harmonic analysis of the output from a normal cochlea should be interpreted with great caution, for we have shown that, even for a stimulating frequency as high as 1,000 c.p.s., a considerable percentage of the measured distortion is apparently due to the presence of the action potential component. At lower frequencies this is even more clearly the case, and it would seem that here previous denervation must be resorted to if any significance is to be attached to the results of this type of experiment. This will be the case since the electrical response cannot reflect the wave-form of the vibration of any intracochlear structure whilst it is distorted by the marked nervous component which it inevitably contains in the normal animal.

The authors are deeply indebted to Dr. M. H. Lurie for performing the histological work whose results are described in this paper, and to Mr. R. S. Sturdy for much assistance in the drawing of figures. To Dr. Hallowell Davis they are grateful for providing the necessary facilities for the electrical work and for many hours of helpful discussion.

REFERENCES

Ashcroft, D. W., Hallpike, C. S., and Rawdon-Smith, A. F. (1937), On the Changes in Histological Structure and Electrical Response of the Cochlea of the Cat following Section of the Eighth Nerve, *Proc. Roy. Soc., London*, B., **122**, 186.

Davis, H. (1935), The Electrical Phenomena of the Cochlea and the Auditory Nerve, *J. Acoust. Soc. Am.*, **6**, 205.

Davis, H., Derbyshire, A. J., Lurie, M. H., and Saul, L. J. (1934), The Electric Response of the Cochlea, *Am. J. Physiol.*, **107**, 311.

Derbyshire, A. J., and Davis, H. (1935), The Action Potentials of the Auditory Nerve, *ibid.*, **113**, 476.

Hallpike, C. S., and Rawdon-Smith, A. F. (1934*a*), The Origin of the Wever and Bray Phenomenon, *J. Physiol.*, **83**, 2, 243.

Id. (1934*b*), The Function of the Tensor Tympani Muscle, *ibid.*, **81**, 25 P.

Id. (1937), The Wever and Bray Phenomenon—A Summary of the Data Concerning the Origin of the Cochlear Effect, *Ann. Otol., Rhin., & Laryng.*, **46**, 976.

Newman, E. B., Stevens, S. S., and Davis, H. (1937), Factors in the Production of Aural Harmonics and Combination Tones, *J. Acoust. Soc. Am.*, **9**, 107.

Rawdon-Smith, A. F. (1938), "Theories of Sensation". Section II—"Audition". Cambridge University Press.

Id. (1939), Recent Progress in the Study of the Auditory Mechanism, *Bull. Anim. Behav.* (in press).

Stevens, S. S., and Davis, H. (1938), "Hearing; its Psychology and Physiology". New York, Wiley.

Wever, E. G., and Bray, C. W. (1930*a*), Action Currents in the Auditory Nerve in Response to Acoustical Stimulation, *Proc. Nat. Acad. Sc.*, Washington, **16**, 344.

Id. (1930*b*), The Nature of Acoustic Response: The Relation Between Sound Frequency and Frequency of Impulses in the Auditory Nerve, *J. Exper. Psychol.*, **13**, 373.

Id. (1938), Distortion in the Ear as Shown by the Electrical Responses of the Cochlea, *J. Acoust. Soc. Am.*, **9**, 227.

The President suggested that the discussion be crystallized as much as possible and be directed first of all to the question of diagnosis of internal-ear deafness as, for example, the value of hearing tests. The bone-conduction test was a very rough one and gave rise to fallacies. Another test was the labyrinthine cold air or irrigation test. After diagnosis came the question of causation and pathology. Injury was becoming a question of extreme importance on account of the very large number of compensation cases occurring in which slight accidents were said to have produced nerve deafness for which heavy compensation was claimed. Here, again, one should as far as possible say to what extent an injury, slight or great, did affect the internal ear.

Sir Edward Mellanby had been carrying out a great deal of work on deficiency diseases, and the effect of vitamin deficiency on the internal ear. Perhaps some of those present had experience of Japan and China where deficiency diseases of this kind were quite common, and might be able to corroborate whether such diseases were accompanied by internal-ear deafness.

Mr. A. J. Wright referred to the class of internal-ear deafness which, when associated with vertigo, was usually known as Ménière's disease, but for which he had suggested the title of "Focal Labyrinthitis" as expressing his views of its pathology. Since he had found that in two-thirds of such cases the auditory symptoms had preceded the vestibular by a long period, the average being over seven years and the maximum thirty years, it was obvious that many cases of internal-ear deafness without vertigo must be similar in pathology to the established Ménière's disease. He suggested that it was possible to recognize this type of internal-ear deafness by the existence of some of the following characteristics: A sensation of fullness in the ear or discomfort which might amount to pain and be felt either in the ear, the side of the head, or in the frontal or occipital region on the same side as the defect in hearing. He believed that it was this sensation which frequently led to the mistaken diagnosis of Eustachian obstruction. The occurrence of a true hyperacusis, usually

for high tones, in the affected ear was very typical, and he had been able to recognize such an increased perception to the extent of 15 decibels above the normal in an audiogram. Apart from this true hyperacusis, there would sometimes be found with the typical picture of a perceptive defect an increased sensitiveness to sounds. Thus, the patient would complain that loud sounds were painful, and in such cases it would sometimes be found that in Weber's test the sound would be referred to the more deaf ear. An allied symptom also frequently present was a distortion in perception, some tones seeming to be sharp or flat, this naturally being most often noticed by individuals with a musical ear. Variability in the hearing was also frequently met with. Mr. Suggit had recorded variability in cases of otosclerosis but he himself thought that there was much more marked variability in cases of the complaint under review. In regard to the type of defect in hearing, the records, as shown by the audiometer, showed a most striking symmetry in the curve on the two sides, such graphs also tending to be of a spiky or patchy type, particularly in the high tones. Finally, in his experience, tinnitus was a constant feature, although it was not infrequently intermittent. As with the hearing, variability was common, and he believed that it was in this disease only that it might assume such a degree of severity as to be almost unbearable.

Dr. Phyllis Kerridge said that she had been interested to hear Mr. Watkyn-Thomas's opinion that the middle ear got damaged much more easily than the inner ear as the result of noise or noisy accidents. She had had occasion to investigate some workmen who for twenty-five or thirty years of their lives had been subject to loud noises for about ten hours a day. The damage to their ears was much slighter than would have been expected. There were evidences of middle-ear defects which preceded inner-ear disease, and the inner-ear damage when it occurred was quite sharply localized. Workmen who had worked up to fifteen years in this noisy environment got middle-ear deafness as a result, and those who went on to work for twenty-five to thirty years got localized inner-ear deafness as well.

With regard to the question of vitamin deficiency she was, of course, acquainted with the work of Sir Edward Mellanby, but in connexion with the investigation of hearing defect in different stages of nutritional deficiency in this country, she had not found a single case of inner-ear deafness which could be compared to this degeneration of the 8th nerve due to vitamin-A deficiency found in animal experiments. A much larger incidence of middle-ear deafness was found among the poorer classes of the community. She intended carrying out some tests with the audiometer in Denmark in which country, during the last War, owing to the fact that they exported all their butter, some people became blind as a result of acute dietetic deficiency and were still in institutions.

She wished to add how much she appreciated the work which Dr. Rawdon-Smith had described. It was not his fault that his paper was one of a long series of disappointments. When the experiments of Wever and Bray were made known they all thought that they had got a new theory of hearing, and later that there was at least a new and intriguing phenomenon ; but now they were coming to think that the phenomenon might be merely a trap. She was not quite clear from Dr. Rawdon-Smith's paper whether he thought the last hope was gone, and that the cochlear response could not even be considered an indication of some process in the cochlea which was a necessary antecedent to the stimulation of the auditory nerve.

Mr. C. S. Hallpike, speaking of Mr. Watkyn-Thomas's paper, said that he had understood him to say that there was some doubt whether increased intracranial pressure led to increased intralabyrinthine pressure. The speaker did not think there could be any doubt on that point because there was the open channel of the aqueduct through which the " tide " ebbed and flowed. Having said that, it was

necessary to point out that the real thing that mattered was whether variation of pressure in the internal ear signified very much to the ear.

Mr. Watkyn-Thomas had said something of Taylor's work on quinine. It would be very interesting if it were proved that adult animals were much less affected than the fœtuses with which they were associated, but E. P. Fowler, Jun., of New York, had investigated in a very careful manner the offspring of mothers who had had considerable quinine medication round about labour, and he had not found evidence that the children were affected.

With regard to Mr. Suggit's paper, he had referred to " definite " X-ray pictures of otosclerosis. That would be very important if the significance of the very difficult X-ray appearances described in the labyrinth by Dr. Graham Hodgson could be accepted as decisive. It was hoped that further work would settle this important question.

With regard to Dr. Rawdon-Smith's paper, he congratulated him on his ingenious use of the denervated cochlea. Nobody had ever said, so far as he knew, that the Wever and Bray effect was anything but an intracochlear one, so that to say that its absence proved deafness irrespective of what might happen in the central pathways was amazing. Such an interpretation might, he supposed, be applied to the quoted statement of Davis and Lurie, and if so the present paper was all the more valuable as a corrective. He referred to another paper by Rawdon-Smith, Ashcroft and himself[1] in which animals with such denervated cochlea were used to a considerable extent. Up to the first three weeks after cutting the nerve if the blood supply was preserved, not only was the Wever-Bray reaction present, but it might actually be present in increased strength, although such animals must obviously have been quite deaf.

Another point of interest was Dr. Rawdon-Smith's work on the harmonic analysis of the cochlear response. Did he find that the contraction of the tympanic muscles had any selective action in cutting down the harmonics to a degree greater than the fundamental ?

In some previous work carried out with Dr. Rawdon-Smith they had rather concluded that this was the case. The experimental method he had in mind was to denervate one cochlea and record from the round window what would be a pure cochlear response ; the tympanic muscles could then be brought in and out of action by a crossed reflex by simultaneous stimulation on the other ear.

Mr. H. V. Forster said he wondered whether hearing tests would be more helpful in localizing cerebral tumours than tests for examining the integrity of the vestibular nervous system. He understood that symptoms referred to the vestibular nervous system appeared to have been aroused when tumours had been implanted in widely distant areas of the brains of experimental animals. With regard to the lowering of the upper tone limit with advancing years, older people were grateful to hear good articulation which emphasized the consonants in speech, but a background noise was particularly trying to them. The rustling of paper or the tearing-open of letters was a type of noise with a particularly effective masking effect. The effect of quinine upon the inner ear had been mentioned, which reminded him that to ask one's female patients about the use of quinine in pessary form *per vaginam* was sometimes a duty but nevertheless an exceedingly delicate question in case-taking. As to the increasing importance of occupational noise he had understood that in those employed in aviation sufferers from sinus disease or incipient ear defects were more liable to be affected than others without these defects.

He believed it to be Temkine's view that in workers in noisy trades healthy workmen withstood deafness for a number of years, but others whose hearing failed

[1] *Proc. Roy. Soc.*, London, 1937, **122**, 186.

early were probably constitutionally liable to failure of the organ of hearing because of infections and intoxications or because they already had incipient defects of the auditory apparatus.

He would not dispute the desirability of removing a definite focus of sepsis in inner-ear deafness, but the element of chance not infrequently made one hesitate to advise operations of this kind.

Mr. Terence Cawthorne said that he wished to lay emphasis on one point regarding the diagnosis of internal-ear deafness. He had noticed that in cases of unilateral internal-ear deafness there was nearly always a false negative Rinne. He felt that it was important to realize this because otherwise it might be easy to fall into the trap of attributing such cases to middle-ear causes. This applied especially to those cases mentioned by Mr. Wright in which there was in addition a paradoxical Weber sign.

With regard to trauma causing nerve deafness, there was a very interesting review of the subject by C. C. Bunch in the *Laryngoscope* of September last year. He had noticed that repeated acoustic trauma causes a marked loss in the high tone register, and had mentioned gun-fire in particular—not the gun-fire of war but of sport. During the present year the speaker had examined three cases of high-tone deafness in the left ear in patients who had done a good deal of shooting. Incidentally, all these patients were right-handed, which accounted for the left ear being more affected than the right.

The speaker had noticed that cases of Ménière's disease had responded in a very consistent way to variation of the fluid balance, and he believed that a low salt diet with reduced fluid intake was a valuable measure in relieving the symptoms in such cases.

Dr. Ritchie Rodger said he was surprised to hear one or two speakers in the discussion referring to middle-ear changes as being present in that form in inner-ear defect usually called noise-deafness. In all the experimental work carried out in the first decade of this century by Wittmaack, Von Eicken, Yoshii and others, it was agreed that the middle ear escaped injury altogether except perhaps in the case of severe explosions where the membrane might be ruptured and hæmorrhages appear.

The occurrence of an incidental otitis media in one animal was observed to have prevented the onset of the degenerative changes in the cochlea, and this led to the experimental induction of suppuration in the middle ear and in other animals the removal of ossicles. In all these cases the inner ear escaped, the middle-ear defect acting apparently as a damper to the excessive sounds. Dr. Rodger himself in 1915 published the results of the examination of the ears of 50 boiler-makers and found clinically the same results. In six of the 100 ears otitis media or its sequelæ were present, and the tuning-fork tests in these ears indicated that the cochlea had escaped. Logically it is what we should expect. It had also been stated to-day that in exposure to injurious sounds, healthy ears in healthy persons always escaped. In the investigation referred to he had proved that even boys who had been only a few months employed in the boiler shops, showed a defective hearing for sounds of the same pitch as the sounds predominating in the workshop, even when the hearing was quite unaffected for tuning-fork sounds well above and well below that range. He found that deafness for high notes was a later development than deafness for sounds corresponding in pitch to the shop noises.

Wing-Commander E. D. D. Dickson said that an investigation had been carried out in the Royal Air Force as to the effect of noise on pilots. Since the introduction of the closed-cabin aircraft, pilots had been in the habit of discarding their helmets, and a series of audiograms had shown that there was always a drop for

the high tones in individuals who exposed their ears to aeroplane engine noise, which is in the neighbourhood of 256 cycles, for a considerable time. This fall was irrespective of the fundamental note which prevailed at the time. Several cases which he had followed up and which had continued to expose the ears had shown a further drop, gradually creeping into the two thousand scale, while in contrast to that, individuals who had maintained full protection for their ears gave, even on the four thousand to five thousand scale, a perfectly straight line. This had been particularly noticed in twin-engine machines. A special form of ear protector had been tried, but it was found that in order to get the adequate protection claimed for it it had to fit perfectly to the external meatus.

He gave an instance of a man who was testing an engine for twenty months and was wearing an Armstrong ear apparatus. An audiogram showed a very marked drop in the hearing by the left ear, more than the right, and on inquiring the reason for that, they were told that he used his left ear for listening to the explosions.

Dr. Thacker Neville said that enough was known of this subject to advise children going to public schools not to go in for the hobby of metal work. The other thing he wanted to say was that he believed one of the earliest signs in Ménière's disease was shortened bone conduction. Was it possible to have an absolutely normal hearing with Ménière's ? He recently saw a woman, aged 38, complaining of giddiness showing nystagmus and vertigo when he placed her head backwards, i.e. positional nystagmus, but there was no other sign of labyrinth disease. He said that she had not Ménière's disease because her hearing was normal as tested by tuning forks. He had suggested that she be referred to a neurologist. The neurologist had pronounced that she had Ménière's disease, and he considered that early Ménière's disease could occur without any effect on the hearing. He thought that the salyrgan test was excellent, as a water-logged patient passed excess of fluid for forty-eight hours, whilst a normal patient passed an excess only in the first twenty-four hours and in the second twenty-four hours the amount of water passed was less than the normal output.

Mr. W. A. Mill said that he had been rather interested in the cases of nerve deafness running in families. He had lately had two such families brought to his notice. In one of them he saw the father, a man aged about 60, and his two sons, one of whom was still at school. They all had marked nerve deafness, and the father told him he was one of a large family all of whom developed the condition, and their children also in many cases. The father's father was also deaf.

Another man came to him quite recently and told him that his brothers had got nerve deafness, and his father, his father's brothers, and his grandfather were all subject to the condition. What was the exact cause in these cases ?

He agreed with Mr. Ritchie Rodger in believing that all damage in cases of deafness due to working in noise were due to damage of the internal ear.

Dr. A. F. Rawdon-Smith, in reply to the question raised by Mr. Hallpike, said that the contraction of the tympanic muscles cut down both fundamental and harmonic responses ; but, as Mr. Hallpike and he had said tentatively in 1934 [1], the harmonics were reduced in greater proportion than was the fundamental. It was now clear that the even harmonics were particularly affected by the muscles in question.

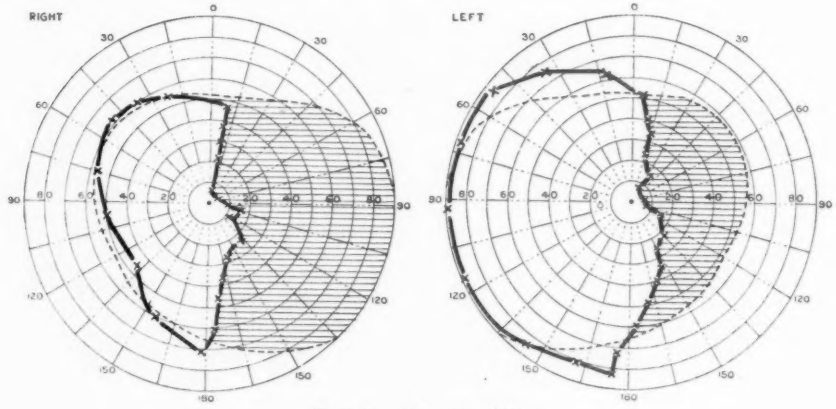
Finally, it might interest Mr. Forster to know that Davis and his collaborators [2] have drawn attention to a physiological mechanism which might well account for the masking of ordinary speech which he had experienced in the House of Commons by people in his vicinity tearing up their papers.

References.—1 HALLPIKE, C. S., and RAWDON-SMITH, A. F., *J. Physiol.*, 1934, **81**, 25P ; 2 DERBYSHIRE, A. J., and DAVIS, H., *Am. J. Physiol.*, 1935, **113**, 476.

The following case was shown :—

Right Hemianopia Persisting Fifteen Years after Cerebral Abscess. — SYDNEY SCOTT, M.S.

R. H. G., engineer, was operated upon for a left otitic-temporo-sphenoidal abscess in July 1923, and made an uninterrupted recovery apart from the restriction in the fields of vision (taken by Sir William Lister, December 1923). Fortunately the macula escaped, and through successful adaptation, he has carried on his profession without interruption.



R.H.G. Dec. 18, 1923.

The only drawback—to which he has long resigned himself—is that he is denied the pleasure of driving a car, because when looking straight ahead, he sees nothing on the right-hand side of the road.

[Fuller notes of this case are contained in a paper read before the Section of Otology, March 1934 (*Proceedings*, **27**, 1677). See also *Journ. Laryng. and Otol.*, **50**, 120.]

Section of Odontology

President—A. H. Parrott, O.B.E., M.D.S.Birm.

[*October* 24, 1938, *continued*]

Enamel Protein

By Paul Pincus, D.D.Sc.Melb., Ph.D.Lond., L.D.S.Vic.

(*From the Hampton Hale Research Laboratory, Royal Dental Hospital, London*)

The purpose of this paper is to direct some attention to the nature of the organic material associated with enamel. Some of this organic material covers newly formed enamel while some permeates enamel. Up to the present it has not been found practicable to examine the surface layer separately from the organic material in the body of the enamel although there is some reason to suppose that they may differ. The technical difficulty of separation of the portions referred to, provides an explanation for the method of presentation of enamel formation. As the surface layer has not been examined separately from the organic material in the body of the enamel they are considered together from the developmental aspect.

I.—Development

It is established that ameloblasts lay down enamel. When enamel formation is complete, the ameloblasts—now apparently functionless—are thought to remain in situ, and eventually to fuse with part of the gum epithelium so forming Nasmyth's membrane. This explanation does not account for the presence of cells on the surface of enamel, as shown by Orban [1], and it may be said that knowledge of the development of Nasmyth's membrane is incomplete.

The study of enamel formation presents difficulties, some shared with embryology in general, others associated with the hardness of the tissue. Newly laid down enamel matrix is soft and readily cut. Between this soft readily cut material and old enamel there are several stages. Chase [2] described four such stages—primary, young, transitional, and hard. These coincide with the phases demonstrated by the aid of a polariscope by von Ebner [3]. Laboratory experience in the preparation by microtome of tooth sections supports these observations. It is clear that the presence of organic material in the body of enamel can be explained on a developmental basis, but while knowledge of calcium metabolism in general remains incomplete, much remains to be added to our knowledge of enamel formation. Chase states " that hypoplastic enamel contains a high proportion of incompletely matured enamel, which is usually in the transitional stage of maturation ".

II.—Distribution

Mastication soon removes Nasmyth's membrane [4] from the exposed parts of teeth, but between cusps of bicuspids and between the cusps of molars it may remain intact throughout life. The teeth of Australian aborigines often show facets of wear caused by a tooth rubbing against its neighbour ; these facets are seldom seen on the teeth of civilized people. It is then possible that Nasmyth's membrane may remain between the teeth during life. Investigation into the distribution of this membrane is affected by the fact that stains do not readily differentiate between this structure and adventitious films of such substances as mucin.

If enamel free from dentine be heated to between 260° C. and 270° C. for ten minutes it changes colour. If apatite, which most nearly corresponds to enamel in

chemical constitution (as shown by Murray) [5], be heated in the same way, it does not change colour. The colour change is from that of normal enamel to a shade resembling a grain of ripe wheat, somewhere between light khaki and buff. This change of colour is not a surface phenomenon but is continuous throughout the thickness of the enamel, and is due to the charring of the organic material present in the enamel. The presence of organic material at the junction of enamel and dentine has long been an accepted fact. About the development of this structure little is known, and about its composition less.

III.—Composition

In my research on caries some work on the organic content of enamel soon became inevitable. Since 1887 when Thompson [6] spoke of an organic matrix of horny matter—" keratine "—this description has been accepted by most writers. It appeared to be a reasonable deduction since enamel is epithelial in origin.

The work of Rosebury [7] is probably the most detailed carried out on the organic material associated with enamel. Using extreme care he collected the material by filing enamel and then removing the inorganic part by acetic acid, collecting the organic part by the aid of dialysis.

I have confirmed some of Rosebury's findings and extended them. My method of collection of organic material is by the use of 2% HCl to remove the inorganic salts. Sound incisor teeth are scrubbed with alkali to remove mucin, the pulps and roots removed, and the crowns decalcified by 2% HCl. The dentine pieces are picked out and the organic material washed and centrifuged several times. For the quantitative results given, unerupted teeth were used. The supply of these is, however, limited, and for some qualitative work non-carious human incisors have been used.

Schematic Arrangement of Some Points of Developmental and Biochemical Aspect

Plants	Lower animals (invertebrates) e.g. insects	Higher animals (vertebrates) (with bony skeleton)
Cellulose (carbohydrate)	Covered by chitin (conjugated carbohydrate and protein)	Covered by keratin (protein only)

Body coverings

Skin and appendages	Appendages of gums—teeth
Hair, feathers, wool, nail, horn, hoof	Nasmyth's membrane and enamel protein
All contain sulphur in the form of cystine	Contains sulphur, possibly in the form of methionin
Molecular linkage is sulphur—sulphur	Molecular linkage is sulphur—carbon only
Resist action of acids	Resist action of acids

In the table is shown one point of difference between lower and higher animals; covering such lower animals as insects, which possess an exoskeleton, there exists chitin, in which there is a high proportion of carbohydrate conjugated with protein. In higher animals, with an endoskeleton, the covering is largely keratin, which is a sclero-protein. Below is shown a short list of some appendages to skin: Hair, feathers, &c., containing sulphur as cystine, with molecular linkage sulphur to sulphur. Teeth are developmentally gum-appendages; here sulphur appears not to be in the form of cystine, but possibly in the form of methionine, in which the molecular linkage is sulphur to carbon. Both keratin and enamel protein resist the action of acids. When collected in the manner described, enamel protein appears as a flocculent,

yellowish-brown mass with density near that of water. Heated on platinum foil to redness the protein is incinerated, only a trace of residue remaining. This trace is soluble in acid, and precipitated by oxalate, and in this respect resembles a calcium compound.

Nitrogen determinations have been made by micro-analysis by Schoeller, and by Weiler. When these were carried out the presence of other organic substances was not suspected. The first series of nitrogen determinations on an ash-free and a moisture-free basis gave a result of 9·2% nitrogen. As proteins range from 12 to 19% nitrogen this low estimation left some doubts as to methods of collecting. Further consideration was given to this point ; it seemed that the material must be organic, i.e. protein, carbohydrate, or fat. For this point Dr. Nanji's assistance was welcome (personal communication). Further collection of material was made and divided into two portions. Of these one was extracted several times with ether and with petroleum ether. The other part of the same collection was dried in air and not exposed to ether. It has been found by micro-analysis that 1% of fatty material is present. Examination of the ash by Dr. Margaret Murray of Bedford College, has shown that approximately 2% calcium is present. When corrections—for ash and for fatty material—are made, the nitrogen determination of the protein is 12·1%, that is within the range covered by proteins.

Tested for the presence of tyrosin by Millon's reagent the protein gives a positive result, that is a red colour. It was difficult to hydrolyse the protein so that further tests for the presence of other amino acids are incomplete.

It has been said that keratins are proteins rich in cystine, though Block and Vickery [8] do not regard this as a necessary characteristic. Rosebury, in the work mentioned above, used the lead test for cystine, but states that " at best it is not a delicate reaction ". A standard test for cystine is the sodium nitro-prusside method. The writer has tested hair, wool, skin, nail, feathers, horn, hoof, all typical keratins, and all giving a marked purple colour with this test, showing the presence of cystine. So far no satisfactory positive result by the use of this method has been seen with enamel protein. This failure to demonstrate the presence of cystine may be due to such causes as : Absence of cystine, difficulty of hydrolysing the protein, presence of sulphur in some form other than cystine, e.g. methionine. Both cystine and methionine are, of course, amino acids containing sulphur. Methionine is of recent discovery (Mueller [9]). It would not be too much to say that the discovery of methionine has necessitated complete revision of our ideas of sulphur-containing compounds in proteins, although Jordan Lloyd [10] states that Danilewsky [11] suggested " that proteins contain sulphur in two different states of combination, some of it being more firmly combined than the remainder ".

It may be of interest to point out that enamel protein has been examined by Kanner in Chicago (personal communication) by the aid of Heyrovsky's palarograph. He claims to be able to detect cystine in amounts as small as one gamma (= one thousandth of a milligramme). By the use of this sensitive method he has not been able to demonstrate the presence of cystine in enamel protein.

One quantitative estimation of sulphur has been done by micro-analysis of enamel protein (Schoeller) ; this showed that 1·2% of sulphur was present. The presence of sulphur has, then, been demonstrated, but so far the presence of the amino acid characteristic of many keratins, cystine, has not been demonstrated. In this respect enamel protein appears to differ from many keratins. It should be pointed out that there are technical difficulties associated with sulphur determination, partly because sulphur is not readily oxidized. In passing it may be noted that when Cape and Kitchin [12] examined enamel protein by the use of polarized light they stated that " if the matrix of enamel is keratin, it is evident that we must consider it as a different type of keratin from any other we have examined ". At the same time the limitations of the method they relied on must be recognized. The percentage of sulphur found

by Schoeller in enamel protein—1·2%—may be contrasted with the figures given by Cole [13] who states that " keratins are proteins containing 2 to 15% of sulphur ".

Other tests have been applied to enamel protein. A faintly positive biuret reaction has been observed. The xantho-proteic test can hardly be considered conclusive—the protein being yellowish when first collected ; some change of colour with this test has, however, been observed. After exposure to boiling alkali no blackening of lead acetate has been seen. It is to be noted that methionine does not split off sulphide on boiling with alkali. Enamel protein has been examined by Dr. W. T. Astbury by the use of X-ray spectography. The results have suggested that the picture differs from that given by some keratins. The principles involved in this novel method, and their application, are described in a series of lectures by Dr. Astbury [14] to students, in his book (1933). The appearance seen by Dr. Astbury with enamel protein, suggested that it resembled a substance separated by him from wool and called, tentatively, " 4·1 protein ", this being a reference to the measurement of the repeat pattern. Supply of enamel protein being of such limited nature it was hoped that the larger quantities of the 4·1 protein available, separated from wool, might facilitate study. Technical difficulties interfered with the method and it was not pursued further. It might be mentioned that the largest collection of enamel protein made so far weighed about 30 mgm. ; this took about six months to collect.

In the field of biochemistry, sulphur compounds and the position occupied by sulphur in the protein molecule, are receiving greater attention than formerly. One aspect, of a clinical nature, is the work being carried out on the sulphonamide compounds in connexion with their bactericidal action.

Enamel protein has been exposed to the action of pepsin, trypsin, and papain. While some attack occurred with each of these enzymes, in no case was complete hydrolysis observed. It is uncertain whether action is extremely slow or whether the protein is not homogeneous and one fraction only is attacked. At an earlier stage of the work it was thought that the protein was soluble in potassium cyanide. This observation proved later to be inaccurate.

Some attention has been given to the point referred to above—the presence of fatty material. This may come from the dentine, although microscopic comparison of hard-ground and decalcified sections of dentine does not support this assumption. Tests have been carried out by the aid of microscopy on the minute quantities of fatty material available. From a consideration of solubilities it is thought that this fatty material resembles in some respects a sterol. This may be of interest in connexion with vitamin D. It is not intended to discuss this aspect in detail as the work is incomplete. Routine methods of examination of fats cannot be applied to the quantity at present available, usually far less than 1 mgm., so that estimations of saponification value, iodine value, or of melting point have not been attempted. There is some doubt as to whether more than one fatty substance is present.

It is well known that the sterols are closely related to bile salts ; substances of this nature are cholane derivatives, all related to phenanthrene. Of the sterols, irradiated ergosterol is calciferol, i.e. vitamin D_2. While it is known that cholesterol and similar substances are widely distributed in the human body, the possibility of their presence or significance in the teeth appears to have been overlooked.

From a consideration of the facts set out above it will be seen that the organic material associated with enamel is a sclero-protein, containing abundant tyrosin. Sulphur does not appear to be present in the form of cystine, but possibly in the form of methionine. It is a protein of resistant nature resembling reticulin.

Proteins of the class just referred to—sclero-proteins—are characterized by their resistance to acid attack and to pepsin.

[Here the speaker showed a series of lantern slides demonstrating the action of acid on enamel—for illustration *see Brit. Dental Journ.*, 1935, **59**, 386–387. Four of these slides are illustrated in figs. 1–4.]

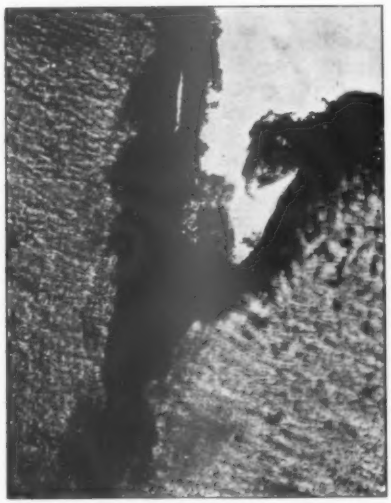


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

Fig. 1 shows the organic material in the occlusal groove on an unerupted bicuspid tooth. Unstained hard ground section. Original × 83.

Figs. 2, 3, 4, show the effect of acid on the groove shown in fig. 1. It may be seen that the organic material filling the groove remains intact while the enamel is removed by the action of the acid. Original × 83.

It will be realized that experiments of this type can obviously never be the exact counterpart of clinical caries, but they are not without interest. From the above approach to the problem of caries it will be clear that acid attack alone is not responsible for the phenomena of caries. In the extensive literature on caries may be found references to the disappearance of Nasmyth's membrane but—if wear be excluded—no reference to the means by which this is brought about. A number of experiments have been carried out with mouth bacteria, and these have confirmed the fact that Nasmyth's membrane is of an extremely resistant nature. Among the bacteria known to be proteolytic are the Clostridia. Mouth organisms of this class have not been extensively studied. A number of hypotheses might be advanced to account for the phenomena of caries; of these, attack on the inorganic portion of enamel—Miller's theory—has, in the past, received most attention, but is not proven. Attack on the organic portion of enamel is a hypothesis which, in the past, has received little or no attention.

Though the study of the organic content of enamel remains at present in a somewhat academic form its possible importance in connexion with the clinical problem of caries should not be overlooked.

REFERENCES

1 Orban, *For. d. Zahn.*, 1930, **9**, 715.
2 Chase, *J. Am. Dent. A.*, 1931, **18**, 697.
3 von Ebner, *Dent. Man. f. Zahn.*, 1903, **21**, 505.
4 Nasmyth, *Med. Chir. Trans.*, 1839, **22**.
5 Murray and Bowes, *Biochem. J.*, 1935, **29**, 12, 2721.
6 Thompson, *Am. J. Dent. Soc.*, 1887, **20**, 433.
7 Rosebury, *J. Dent. Research*, 1930, **10**, 187.
8 Block and Vickery, *J. Biol. Chem.*, 1931, **93**, 1, 113.
9 Mueller, *ibid.*, 1923, **56**, 157.
10 Jordan Lloyd, and Shore, "Chemistry of the Proteins". Churchill, London, 1938.
11 Danilewsky, *Ztschr. f. physiol. Chem.*, 1882, **7**, 440.
12 Cape and Kitchin, *J. Am. Dent. A.*, 1930, **17**, 193.
13 Cole, "Pract. Physiol. Chem". Cambridge, 1933.
14 Astbury, "Fundamentals of Fibre-Structure". Oxford University Press, London, 1933.

Section of Medicine

President—H. L. Tidy, M.D.

[*November* 22, 1938]

DISCUSSION ON GASTROSCOPY

Gastroscopy

By H. W. Rodgers, F.R.C.S.

Introduction

Gastroscopy is not a new method, but its recent popularity is due entirely to the invention of the Wolf-Schindler flexible gastroscope, an instrument which is incomparably safer than any of the older rigid or jointed gastroscopes. Arafa spoke about it before this Society in 1935, and many surgeons tried using the instrument, but it was Edwards at King's College Hospital who first reintroduced the method into this country; almost simultaneously it began to be used at St. Bartholomew's Hospital. This was in January 1935, but by the end of that year Aitkin, Avery Jones, Hancock, Lintott, Taylor and others had begun to take up gastroscopy in earnest. The chief advantage of the new instrument and the reason for its sudden popularity lay in the safety with which it could be used.

The instrument is passed under local anæsthesia, on a fasting stomach. Premedication is desirable but by no means necessary. The patient lies on an ordinary operating table covered with a soft mattress.

Indications for use.—Gastroscopy should be used first in the everyday diagnosis of gastric disease and second for research purposes. I would suggest that no case of chronic dyspepsia has been adequately dealt with unless an anatomical lesion has been satisfactorily excluded before treatment is begun. The textbooks tell us that if dyspepsia in the middle aged does not rapidly respond to treatment the patient should should be investigated for carcinoma, but as cases of carcinoma almost invariably improve on medical treatment, surgery may be delayed for several months by not making an examination before beginning treatment.

The practical indications for gastroscopy.—(1) It should be performed when a skiagram has shown some abnormality but no definite diagnosis has been made; or when, a diagnosis having been made, some additional information is required.

(2) It should be performed in cases of dyspepsia in which skiagrams have revealed no abnormality. Unfortunately it is impossible to investigate fully all cases of dyspepsia; the choice of cases for full investigation will depend upon the physician's own experience and judgment.

(3) In certain cases of anæmia its use is of interest, although of little practical value.

Contra-indications.—It is seldom that one cannot gastroscope a patient but nevertheless there are certain rare conditions, either local or general, in which gastroscopy is contra-indicated. The local conditions may be trismus, œsophageal stenosis, and deformity of the œsophagus, either by tumours pressing on it from without, such as mediastinal glands, or aneurism, or by severe curvature of the spine. Lesions at the cardiac orifice of the stomach, particularly large carcinomata, may contra-indicate gastroscopy if they obstruct the passage of the gastroscope or render its introduction dangerous. Further, it is inadvisable to gastroscope within a few days of a severe hæmatemesis.

Blind-areas.—The extent of the stomach which is visible is large. There are nevertheless certain blind areas first of which is the area immediately ahead of the gastroscope. This area can be lessened, but its examination can probably never be complete with the usual instrument. The second is the lesser curvature of the antrum, which in the long type of stomach is often invisible. In the majority of cases this can be seen satisfactorily by deflating the stomach through a special tube which I have had attached to the sheath of the gastroscope. In the Japanese gastroscope an attempt has been made to overcome this difficulty. Third, the upper part of the lesser curvature and fourth, the adjacent posterior wall, are often difficult or impossible to see, even with the use of the balloon device. Last, the medial part of the fundus is, as a rule, out of view.

The first three areas are important, for in these places lesions commonly occur, and our inability to examine them satisfactorily with the gastroscope is a great disadvantage.

Another disadvantage with gastroscopy is that it is not entirely without danger, since fatalities have been recorded, although as far as I know none has occurred in this country. Sore throat is a common sequel, occurring in about 30% of cases. It is usually mild and passes off within a day or two ; it is rarely severe enough to produce a rise in temperature.

Normal appearances.—Before proceeding, I think it would be wise if I were to describe briefly some of the normal appearances (Plate I, Nos. 1 to 4). The colour of the gastric mucosa is very fairly represented by the drawings. It is a bright orange red being covered by a thin transparent layer of mucus which gives it a very high polish ; consequently reflections of light are numerous and bright. They are not represented in these drawings in anything like their natural brilliance because they are impossible to reproduce. The colour varies considerably with the phase of digestion, and therefore gastroscopy must always be done on a fasting stomach. I have also found that out-patients, although they may have fasted for twelve hours have, as a rule, a much more hyperæmic mucosa than those who have not had to make a journey to hospital before being gastroscoped. I think this is an observation of some importance because the colour of the mucosa often influences one's diagnosis.

There is a great deal of variation, within the limits of normality, of the height of the mucosal folds and of the distinctness with which the areæ gastricæ can be seen. The physiological activity of the mucosa is dependent upon its anatomical development. In the graph (fig. 1) (which was prepared from an analysis of 200 cases) the vertical scale represents the highest acid value produced in a gruel test meal and the horizontal scale shows an arbitrary grading of (*a*) the size of the folds (the smallest one called 1 and the largest 4) (Plate I, Nos. 2 and 3), (*b*) the prominence of the areæ gastricæ, and (*c*) the visibility of the submucosal blood-vessels. It can be seen that the size of the folds and of the areæ gastricæ and the concentration of acid in the gastric contents increase with one another. This prominence of areæ gastricæ is often so marked in cases of hyper-acidity that most authors refer to it quite erroneously as hypertrophic gastritis. I wish therefore to emphasize that it is not a gastritis, but a constitutional variation unrelated to inflammation.

Cases in which an abnormality of uncertain nature is found by X-rays.—If a definite diagnosis of carcinoma is made by X-ray examination it is usual to proceed with surgery without delay. However some authorities, notably Schindler, insist on a routine gastroscopy claiming that by showing the extent of submucous infiltration one may avoid purely exploratory laparotomies. On the other hand gastroscopy can never determine for certain whether a growth is operable, for it can give no information about subserous, lymphatic or vascular spread, which may be extensive in the presence of even a small mucosal lesion.

When the X-ray diagnosis is in doubt gastroscopy should always be performed. In some cases the diagnosis will be confirmed, and laparotomy will not be delayed. These cases are fairly numerous, especially if the radiologist is more anxious to benefit by the gastroscopic control of his diagnosis than to be dogmatic about an uncertainty. Any statistics I could give would have too large an error in selection to be of value.

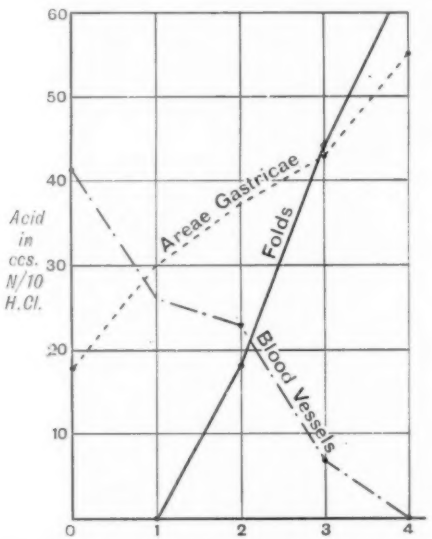


FIG. 1.—A graph illustrating the acidity which varies directly in proportion to the size of folds and the prominence of the areæ gastricæ, and inversely with the visibility of the blood-vessels which represent the thinness and transparency of the mucosa.

More numerous are the cases in which the doubtful area is inspected satisfactorily and found either to be normal or to show some non-malignant lesion, such as an old fibrotic deformity of the mucosal pattern or a localized patch of gastritis. The drawing (fig. 2) shows a few typical X-ray outlines of this type. The corrugated iron pattern, the immobile conical pylorus, and the scalloped outline are all signs of early carcinoma to which Dr. René Gutmann has brilliantly drawn attention, but, just because they are signs of early disease, it is often difficult to be sure of them, and the radiologist should never dispel his suspicions with dogmatism, but should submit the case for trial by gastroscopy.

During the four years I have been doing gastroscopies I have only once diagnosed an innocent gastric ulcer, seen it heal, and a year later found that it had become carcinomatous. The gastroscopic evidence of malignant degeneration is first, a

raised edge, irregular in colour and knobbly in contour, second an uneven base, in which altered blood and necrotic tissue can be seen, third, an irregular deformity or nodularity in the folds converging to the ulcer, and fourth, the raising of the whole ulcer above the level of the surrounding mucosa (Plate I, No. 6). Using these criteria I have often diagnosed ulcer-cancer, but subsequent section has shown more often than not that these changes have been produced by inflammation rather than by new growth. A large gastric ulcer before treatment is usually surrounded by a zone of acute inflammation. When this subsides, any neoplastic change present becomes more obvious. I have also examined several cases in which the lesion was an obvious carcinoma with no gastroscopic evidence of its having arisen from an innocent ulcer, and in which microscopic section showed that the ulcer had a fibrous

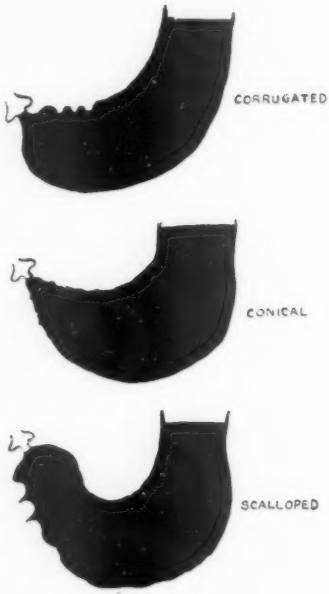


FIG. 2.

base devoid of muscle-fibres. Schindler says he has never seen an innocent ulcer undergo malignant degeneration. He also makes rather far-reaching claims for the accuracy with which he can diagnose early carcinoma; claims which one would be inclined to dismiss were it not for his immense experience.

I would like to say here that although I have diagnosed 18 cases of carcinoma in stomachs apparently normal radiologically, it is probable that in none of these cases was the lesion so small as to be beyond the reach of a more searching examination. In many of them my colleague, Dr. Simon, has subsequently been able to find either a definite carcinoma or niche or at least a suspicious area. Nevertheless gastroscopy, even if only by putting a keener edge on radiological accuracy, will improve the prognosis of carcinoma of the stomach for the few; and although this may be a very small percentage of all cases seen, it is large compared with the proportion of five-year survivals, which at Bart's, before gastroscopy, was not quite 2% of all cases admitted to the hospital.

"*Pre-cancer.*"—The position of carcinoma remains so gloomy that I cannot leave it without some reference to the possibility of a precancerous lesion. An atrophic chronically inflamed mucosa is very frequently seen associated with carcinoma, and is sometimes seen without it. In the tongue and hypopharynx this is especially the case, and in these situations this condition is now recognized as precancerous. Believing in analogy, we have in the Cancer Department at Bart's begun to collect for "follow-up" purposes cases with a chronically inflamed atrophic gastric mucosa in the hope that we may spot a few early cases of carcinoma. Nevertheless, while so large a proportion of cases of gastric cancer remain symptom-free until quite inoperable, the position of affairs will remain gloomy.

Gastric ulcer (Plate I, No. 5).—Gastroscopy is of the greatest value when on radiological examination an ulcer is suspected because of an incisura on the greater curvature, since it usually confirms the presence of the ulcer: when a doubtful niche is found gastroscopy usually proves that no ulcer is present.

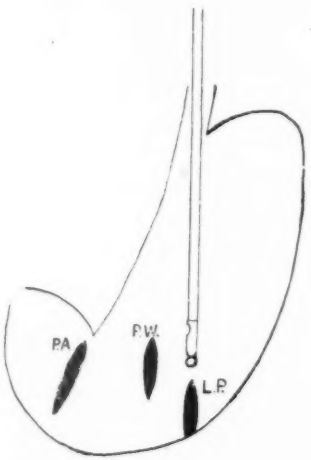


FIG. 3.

In following the healing of a gastric ulcer gastroscopy is of great service. In the investigation of the dyspepsia of patients who have had gastric operations, although beset with many difficulties, it is a valuable procedure.

A gastro-jejunal stoma is not always easy to see, and the usual landmarks are often very distorted. It may be seen in the posterior wall of the antrum, at a distance of about 2 to 3 in., when a good view in one field will be obtained (fig. 3, P.A.). Detail at this distance is usually quite distinct, and examination of the gastric surface satisfactory. The closer the mucosa approaches the line of the gastroscope the more it will be magnified (fig. 3, P.W.), but if too close to the instrument, the mucosa may lie in contact with the objective lens and no satisfactory view will be obtained, even with the use of the balloon device. Occasionally, however, when the stoma lies at the lower pole, the gastroscope slips into one or other loop of jejunum coming to the anastomosis, and then an excellent close-up of most of the anastomotic ring as well as of a few inches of the loop of jejunum concerned is obtained (fig. 3, L.P.). It must be realized, however, that it is only the gastric side of the stoma that can usually

be seen satisfactorily, and, with this last exception, only a limited amount of jejunum is visible through the stoma.

It is very interesting to find that in some cases the pyloric antrum retains its normal size, shape, colour, and activity, while in others it is small, contracted, pale, and immobile.

After partial gastrectomy the stoma is usually easily seen.

A feature of great interest is that in a large proportion of gastrectomy cases the body mucosa often shows quite pronounced atrophy, more marked after the Bilroth I than after the Bilroth II operation, whereas gastritis is not so often seen as in gastro-jejunostomy cases, in which the mucosa is usually well preserved, although often severely inflamed. The atrophy seen in the gastrectomy cases is therefore not due to gastritis but to some other factor possibly connected with the loss of the pyloric antrum.

Gastritis.—By a study of the direction, width and pliability of the gastric folds it is possible to diagnose on X-ray examination the presence of an inflamed and œdematous mucosa. The folds are wider, more tortuous, and rigid, and because the barium cannot fill the narrow valleys, already filled with mucus, between the swollen folds, the mucosal pattern becomes very distorted, and a diagnosis of hypertrophic gastritis is made, and if taken in conjunction with the clinical signs usually means that acute gastritis is present. A very similar distortion of the mucosal pattern may occur with a very atrophic mucosa where there are no proper valleys between the folds to fill with barium. It was such paradoxical findings as these which led Henning and Schatski, working in close collaboration, to conclude that the radiological diagnosis of gastritis was not useless but full of uncertainty. My own feeling is that while the relief technique may be a valuable method in the hands of the very experienced it should, even then, be supplemented by gastroscopy whenever possible, particularly where the findings in a case of so-called severe gastritis remain unchanged after prolonged treatment. It is of more value in the acute forms of gastritis, where it is seldom used, than in the chronic.

X-ray negative cases.—Before we come to the value of gastroscopy in cases of dyspepsia with normal X-ray findings, we must be careful not to compare the successes of gastroscopy with the failures of radiology. Any comparison must be made at the same level.

The question of the selection of cases is quite simple. Any case which is serious enough to be X-rayed should also be gastroscoped unless one of the recognized contra-indications to gastroscopy is present, or unless the X-ray has been done in a case of psychogenic dyspepsia merely to impress the patient. It is not enough to have excluded by X-rays only such gross lesions as a carcinoma or a large chronic ulcer. Wisdom begat early diagnosis, but it also begat another son, masterly inactivity, the sworn enemy of quackery. It is quackery, or at best stupidity, to treat a patient for gastritis if you can prove by gastroscopy that he has not got it.

The next and perhaps the most important question is what lesions can gastroscopy demonstrate, which X-rays and other methods cannot.

1. (*a*) Ulcers less than about $\frac{1}{6}$ in. across, unless they penetrate deeply, are difficult, and if very shallow may be impossible, to find radiologically. Working with Dr. Avery Jones, I have been able to find shallow subacute ulcers associated with atrophy of the mucosa in 25 cases of X-ray-negative dyspepsia. The ulcers often were accompanied by quite severe discomfort and pain, and yielded rapidly to treatment.

(*b*) Erosions of the type seen in the drawing (Plate II, No. 7) are found occasionally in a well-developed mucosa, and are usually accompanied by other signs of inflammation and by small submucous hæmorrhages.

(c) Large chronic ulcers are sometimes unexpectedly found, especially in the upper parts of the lesser curvature, where efficient X-ray examination is difficult.

2. I have discovered nine cases of small sessile tumours, probably adenomata; it is interesting to note that all these have been in atrophic mucosæ, and usually associated with pernicious anæmia or simple achlorhydric anæmia. They may be precancerous lesions, and on this account their discovery may be of importance. All of them were undiagnosed by X-ray, and in a few in which this examination was repeated still no lesion could be demonstrated even by the mucosal relief technique.

Gastritis.—The diagnosis of gastritis is perhaps the most important function of gastroscopy, and it has the field more or less to itself as far as the living stomach is concerned. Histology, the final count of appeal, is very seldom available. The classification of gastritis given by Schindler is :—

Acute exogenous, corrosive, infectious and toxic (hæmatogenous), phlegmonous.

Chronic non-specific superficial, atrophic, hypertrophic.

Other special varieties.

Acute exogenous gastritis is easy to recognize. The usual signs of inflammation are present. The mucosa is congested, the folds are swollen and packed closer together. They are covered irregularly with mucofibrinous pus. There may be occasional submucous hæmorrhages and even superficial excoriation, especially on the top of the folds. The signs long outlast the symptoms, and indicate that treatment should be prolonged for a fortnight at least.

Corrosive gastritis, due to the drinking of strong corrosives, is rare in this country, but in Central and Eastern Europe where the forms of government or the economic conditions make suicide seem desirable, gastroscopists have opportunities denied to us here.

Toxic gastritis.—It is seldom possible to gastroscope a patient with toxic gastritis, but it can be done occasionally and it does teach us to take seriously the gastric symptoms of patients suffering from acute sepsis, as they are usually due to a diffuse gastritis, often with erosions.

Chronic gastritis.—Schindler's is the simplest classification of simple chronic gastritis, and Gutzeit with certain reservations also accepts it. Moutier's rather elaborate subdivisions are unjustified. Henning adopts the most reasonable attitude in dealing with it as one disease. This would seem to be the correct attitude, for the various phases and stages of the disease occur in almost every possible combination, and defy classification. I intend to describe the various manifestations of inflammation first and to discuss them briefly.

(1) *Hyperæmia* occurs during normal digestion, and a stomach gastroscoped after a meal has a very angry red appearance, which is, however, uniform in distribution and quite distinct from the patchy hyperæmia of an inflamed stomach. Another indication of hyperæmia is the visibility of fine intramucosal vessels (Plate II, No. 8). They can only be seen in those parts of the mucosa which, lying very close to the lens, are magnified. This is a very important sign of chronic gastritis, and it is usually, if not always, overlooked in the literature on the subject.

(2) *Œdema* with swelling of the folds is usually readily recognizable and is generally accompanied by exudation.

(3) There may be exudation of white or greenish material probably fibrino-purulent mucus. If such material, seen lying on the surface, is really inflammatory exudate and is wiped off the surface by the use of the gastric probe, a red patch is uncovered. This is a valuable test.

(4) The mucosa, even if uncovered by exudate, may have a dull and rather roughened surface.

(5) Mucosal hæmorrhages (Plate II, No. 10) are often seen, especially associated with ulceration. The hæmorrhage is probably the result not of inflammation but

of a neurovascular event. The mucosa over the hæmorrhage may subsequently slough, and a small ulcer will be produced.

(6) Ulceration and erosion have already been dealt with; superficial excoriation may also occur.

(7) Granularity (Plate II, No. 11) of the mucosa is a common sign to be distinguished from an abnormal but not inflammatory prominence of the areæ gastricæ; indeed gastritis may destroy their pattern.

(8) Deformity of the folds (Plate II, No. 9) due to the swelling caused by an inflammatory process is another sign. When it subsides the folds may be left distorted, and here and there a fold may even be obliterated.

(9) Faber has shown that repeated attacks of gastritis lead to atrophy of the mucosa. This is usually a patchy atrophy, and adjacent to an area of mucosa in which vessels are easily visible the mucosa may be quite thick (Plate II, No. 12).

These various phenomena may be seen in many different combinations, and it is important in assessing the case to realize that while hyperæmia, œdema, exudation, hæmorrhages, and ulceration are signs of active inflammation, granularity, narrowed, distorted or obliterated folds, and atrophy are the results of inflammation not necessarily still active.

Diffuse non-inflammatory lesions.—(1) It is possible that the very thick body mucosa, with high folds and prominent areæ gastricæ, seen in a few cases of excessive hyperacidity, may represent a pathological hypertrophy of the body mucosa. The antral mucosa in these cases is sometimes thinner than usual.

(2) The diffuse atrophy of the body mucosa seen in pernicious and simple achlorhydric anæmia is not the result of gastritis, but of some other, possibly endocrine, disturbance, and it is quite wrong in my opinion to call it atrophic gastritis.

LEGENDS FOR PLATES I AND II.

PLATE I (Nos. 1 to 6).

No. 1.—A normal pyloric antrum in a rather long type of stomach. The lesser curvature at the level of the incisura angularis is at 12 o'clock, the greater at 6. The greater curvature of the antrum is clearly seen and can be followed up to the region of the sphincter (the dark cavity).

No. 2.—A view of the lesser curvature and angulus in a normal stomach. The gastroscope lies about 3 in. higher than in the last drawing. Note the smooth mucosa.

No. 3.—Large mucosal folds on the posterior wall.

No. 4.—Small mucosal folds on the posterior wall (the same degree of inflation as in No. 3).

No. 5.—A small gastric ulcer about one-third inch in diameter on the lesser curve just above the incisura angularis.

No. 6.—A carcinoma (ulcer-cancer) on the lesser curvature and anterior wall of the stomach.

PLATE II (Nos. 7 to 12).

No. 7.—The lesser curvature above the angulus showing hypertrophic mucosa especially on the fold between 11 and 12 o'clock. The pebble-beach appearance due to prominent areæ gastricæ can be well seen. An erosion is also visible.

No. 8.—A view of the lesser curvature and angulus, with the pyloric antrum below. The mucosa shows dilated intramucosal vessels which normally are not visible. The vessels shown here are much coarser and more distinct than the usual type of intramucosal vessels found. These form a very delicate pattern, too fine to be represented in a drawing of this type.

No. 9.—Deformed and œdematous folds.

No. 10.—The anterior wall and greater curvature, showing the pyloric antrum above and to the right. There are four small submucosal hæmorrhages, and a little excess of white fibrinous mucus. The gastroscopic probe is also shown.

No. 11.—Granularity of the mucosa proximal to the angulus. This is an irregular irregularity, quite distinct from the appearance seen in No. 7, in which the areæ gastricæ are well preserved.

No. 12.—The anterior wall at the entrance to the pyloric antrum. In the left-hand side of the picture atrophic body mucosa can be seen. To the right is the normal pyloric mucosa. This rather exaggerates a line of demarcation sometimes seen in cases of pernicious and simple achlorhydric anæmia.

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Section of Medicine.

PLATE I.

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H. W. RODGERS: Gastroscopy.

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PLATE II.

John Bale, Sons & Curnow, Ltd. London.

H. W. RODGERS: Gastroscopy.

Gastroscopy in Achlorhydria

By Professor S. J. Hartfall, M.D.

I shall consider chiefly the gastroscopic appearance of the stomach mucosa in achlorhydria, and attempt to correlate the condition with the disturbed gastric secretion revealed by the fractional and histamine test meals.

The total number of cases with achlorhydria in the gruel fractional test meal which have been gastroscopically examined is 178. Of these, 34 had carcinoma ventriculi, and are excluded from the present paper. There are 32 cases of pernicious anæmia and subacute combined degeneration of the cord, of which 22 have been examined more than once at intervals ranging from six months to two years. There are 42 anæmias of hypochromic type (achlorhydric anæmia). Six post-gastrectomy or post-gastro-enterostomy anæmias are excluded from further consideration. Some of the patients in this group have also been examined after various intervals. The remaining, or miscellaneous, group consists of 70 cases of complete achlorhydria in whom no anæmia is present, but who suffer from a variety of dyspeptic symptoms.

I wish first to discuss the gastroscopic appearances found in these three groups, and to state the broad differences which exist in them ; to refer briefly to some essential histological differences in the gastric mucous membrane ; to describe the differences in gastric secretion found on examination of the histamine juice ; and then to attempt to correlate these three groups of facts.

Gastroscopic appearance in pernicious anæmia and subacute combined degeneration of the cord.—The changes encountered in this group of cases are essentially those of a diffuse atrophy of the mucous membrane of the body of the stomach. All gastroscopists seem to agree that the most extreme changes of atrophy, or what has been called atrophy, are seen in pernicious anæmia. My own experience has confirmed this appearance in the majority of the 32 cases which I am now considering. If the cases are examined while still anæmic, and in a state of relapse, the mucous membrane of the body of the stomach is not only atrophic and thin, but extremely pale. This pallor and thinness, as I have said, affect the whole of the body mucous membrane of the stomach. The characteristic thinness is judged upon the height and thickness of the mucosal folds and the ease of their obliteration on air inflation. The extreme pale colour is largely an effect of the anæmia, as when the cases are examined later, after the anæmia has been satisfactorily treated, this extreme pallor is no longer present. In pernicious anæmia the mucosal folds are only small and somewhat irregular, and are easily obliterated. Finally, the most characteristic feature of all is the presence of branching submucosal vessels which impart a bluish network to the thin, pale, wash-leather background. This gastroscopic picture is one which is easily recognized and is very striking. It is most commonly seen in pernicious anæmia but may occasionally be met with in other conditions.

I would stress the characteristic thinness of the gastroscopic appearance. The mucous membrane never has the thick and mammillated appearance such as is seen, for example, in cases of duodenal ulcer. Although this thinness and atrophy are usually widespread—indeed universal over the whole body of the stomach—three of my cases had areas which were not so affected and in which one would be justified in saying that the atrophic gastritis was not universal. The first picture shows an extreme example of atrophic gastritis contrasted with the so-called hypertrophic gastritis. I show this picture merely for contrast : with hypertrophic gastritis I am not now concerned. It is very unusual to find superficial or erosive changes in cases of pernicious anæmia. I have never seen anything which could be mistaken for an ulcer. On two occasions there were one or two punctate erosions present, but

the absence of superficial change is, to my mind, characteristic of this particular picture.

I have re-examined 22 of these cases of pernicious anæmia ; 8 of them once only, 14 of them two or more times. The intervals between the examinations have ranged from six months to two years and are shown in Table I. The most striking change

TABLE I.—GASTROSCOPIC EXAMINATION OF CASES OF PERNICIOUS ANÆMIA AFTER VARIOUS TIME INTERVALS.

				Degree of atrophy		
				1st	2nd	3rd
32					3	29
	Improvement in colour	Visibility of vessels				
		I.S.Q.	Reduced			
22 re-examined						
16 after 6/12	21	20	2		2	20
6 between 6/12 and 1 year						
14 of these re-examined after 1–1½ years	14	13	1		1	13
12 re-examined after 2 years	12	1			1	11

that is seen is the improvement in the paleness of the mucous membrane. If a record is kept by an artist of the actual colour of the mucous membrane when first examined, and then when examined at a later stage, this fact is well appreciated ; but the small folds of mucous membrane are still easily obliterated, and the vessels are still seen with equal ease in the great majority of cases. It is natural to believe that the extreme pallor is due to the anæmia and may be roughly proportional to the hæmoglobin. It is certainly less marked in the re-examined cases who have had their anæmia adequately treated. It has been claimed by some that the mucous membrane is seen to regenerate. I can only say that in my experience I have never been convinced that this happens ; the mucous membrane appears to remain thin even in cases examined at the longest intervals of two to two and a half years on full treatment of their blood disorder.

Gastroscopic appearance in achlorhydric anæmias.—These are cases of chronic hypochromic anæmia including three of Plummer-Vinson's syndrome, two of an obscure nutritional anæmia with polyneuritis, and the remainder of simple achlorhydric anæmia types. No patients who have had gastric hæmorrhage or operations on the stomach are included. 36 such cases have been examined and a proportion of them re-examined at intervals of the treatment.

Here the changes in the mucous membrane of the stomach are similar to those seen in pernicious anæmia : the atrophy is diffuse and more or less of the same type ; it affects the body and is usually widespread, but one gains the impression that in general the total change in the mucosa is perhaps not quite as extreme as in pernicious anæmia. The mucous membrane again is thin and the vessels of the submucosa are easily visible, though perhaps not so constantly easily visible in all parts of the stomach as in pernicious anæmia. Sometimes submucous hæmorrhages, probably of spontaneous origin, may be seen in this group of cases. In 12% of these cases superficial erosions have been seen, usually along the lesser curvature. Sometimes these erosions have attained a size which suggests that they may be subacute ulcers, but re-examination within two weeks in two cases has shown that they have completely disappeared.

Re-examination of these patients after adequate iron treatment and improvement in the blood has shown that there is again a similar improvement in the pallor of the mucous membrane, but otherwise very little real alteration in the thickness of the mucous membrane, or indeed any suggestion of a return to normal.

Gastroscopic appearance in achlorhydria without anæmia but associated with vague dyspepsia and gastro-intestinal symptoms.—Whereas patchy atrophic change is only rarely seen in the two previous groups of cases, in this group patchy change is the usual finding ; but while there are atrophic areas there is a number of unaffected and other areas which suggest hypertrophic change. In addition, in this series superficial change, perhaps superimposed superficial change, occurs with greater frequency—as great as 60%. Finally, there are 10% in whom no definite abnormality of the gastric mucosa could be found. Erosions are more frequent, and in some cases there are lesions which suggest acute ulcer, especially when they occur on the ulcer sites. These " pseudo-ulcers " were seen as frequently as 15% in this group. Polyps were seen in two cases. Other patches of mucous membrane look somewhat œdematous, thick, red, and opaque, but in adjacent areas there are pale, atrophic, thin portions of mucous membrane. Submucous hæmorrhages are common ; opaque mucus and even blood-stained mucus have been seen in a small proportion of such cases. It is, of course, remarkable, and worthy of special comment, if these erosions do in some cases lead to acute ulceration or are in some way identical with it, for here is the possibility of acute ulceration occurring in achlorhydric stomachs. I may add that I have never seen a definite subacute or chronic ulcer, certainly not a chronic ulcer, in such cases.

TABLE II.

		Normal	Patchy	Diffuse	Hypertrophic	Atrophic	Superficial	Erosions	"Acute ulcers"	Hæmorrhages
Flatulent dyspepsia ..	27	2	24	1	14	12	18	7	4	2
Nervous dyspepsia, migraine, neurosis	15	1	14	—	7	7	6	6	—	1
Irregular ulcer dyspepsia ..	13	—	13	—	11	7	12	5	8	8
Simulating duodenal ulcer ..	2	—	2	—	2	—	2	—	—	—
Gastrogenous diarrhœa ..	7	1	6	—	6	6	4	—	—	—
Gastrogenous polyneuritis ..	2	—	—	2	—	—	—	—	—	—
No symptoms	4	3	1	—	1	1	—	1	—	—

So much for the gastroscopic appearances in these three groups of cases. To summarize, in the pernicious anæmia group I would stress the intense mucosal atrophic changes affecting the body of the stomach almost universally. Only very occasionally is patchy change seen. The atrophic change is irreversible even after prolonged optimum treatment. In the achlorhydric anæmia group (simple achlorhydric anæmia) similar but less intense atrophic changes in the body mucosa are seen. Occasionally erosions may be present with slight superficial changes. In the case of achlorhydria with no anæmia the changes are almost always of mixed atrophic and probably hypertrophic type. Erosions are much more common, and an appearance suggestive of acute ulceration is sometimes seen ; but in general there is a tendency for much more marked, or much more impressive, superficial gastritic change to be present.

It is questionable whether very reliable inferences as regards the finer grades of thickness of the gastric mucous membrane can be made from gastroscopic appearance, since, after all, one is merely viewing the surface of the mucous membrane under different degrees of intra-gastric pressure. No one is in doubt, however, as to the difference in the mucosal picture, for example, in cases of duodenal ulcer where the mucous membrane is commonly mammillated and thickened, from that in pernicious anæmia, where it is atrophic and thin. These gastroscopic observations as to thinness and thickness are represented in the diagram (fig. 1, p. 12).

Some supporting evidence for this conception can be gained from the histological examination of different types of stomach. Fig. 1 shows the gastric mucous membrane of the body of the stomach in a normal healthy individual, as free from gastritic changes as one can hope to be in this world of infections and digestive assaults.

The next picture is one of chronic gastritis such as is found with achlorhydria in the third group of cases which I have discussed. Finally there is an example of the extreme atrophic state of the gastric mucous membrane which is seen in pernicious anæmia. These histological sections support the hypothesis of a progressive thinning of the gastric mucous membrane—most extensive in pernicious anæmia. [Lantern slides were shown illustrating these points.]

Secretory defects in achlorhydria.—Some time ago I made observations upon the difference in gastric secretion under the influence of histamine in cases of pernicious anæmia and simple achlorhydric anæmia, both groups having complete histamine achlorhydria. Similar observations were made in a group of mildly anæmic cases

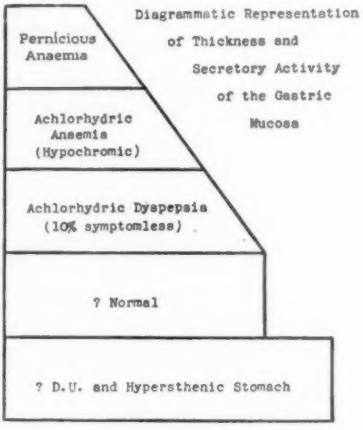


FIG. 1.

with fractional test meal achlorhydria, but in whom histamine produced a small amount of acid (hypochlorhydric group). I present these on one chart (fig. 2). The second chart (fig. 3) illustrates more extreme differences of secretion between a group of cases (12) of duodenal ulcer who represent the hypersthenic gastric diathesis, 12 normal cases and 25 cases of pernicious anæmia. There is a remarkable difference in the secretory activity, both as regards volume and as regards the qualitative character of the gastric juice secreted. The average response of the ten-minute volume of gastric juice secreted in response to a standard dose of histamine, calculated on body-weight, shows that there is a remarkable gradation in the secretory capacity of the stomach so far as the volume of the gastric juice is concerned. More interesting still are the changes in the qualitative character of the gastric juice seen in this same group of 12 cases representing the hypersthenic gastric diathesis, i.e. duodenal ulcer cases ; and a group representative of the hyposthenic gastric diathesis selected from the third grade of achlorhydric cases with no anæmia but with vague gastric disturbances. Not only is there marked difference in volume secretion and in free acid and pepsin, but the total amount of insoluble mucus is greater in the hyposthenic, while in total output the soluble muco-protein remains higher in the hypersthenic group (figs. 4 and 5).

The suggestion of a progressive disturbance of the gastric mucous membrane seen gastroscopically in cases of achlorhydria receives support from histology and from examination of the gastric juice secreted in the stomach in response to histamine.

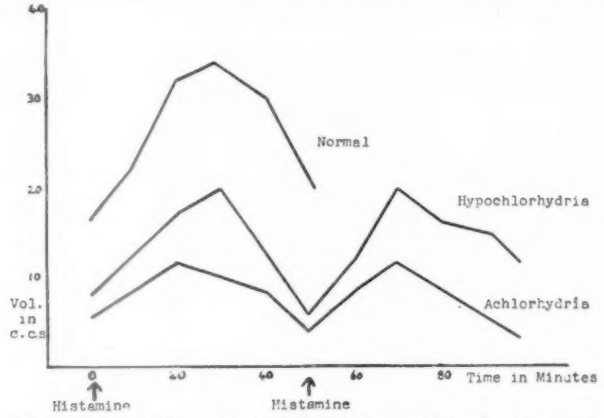


FIG. 2.—Average volume of gastric juice secreted after histamine in normal subjects and in cases of hypo- and achlorhydria with hypochromic anæmia.

The two extremes are seen when the hypersthenic duodenal ulcer types are contrasted with pernicious anæmia. It would at present be unwise to over-elaborate the possibilities among the intervening achlorhydric groups which I have discussed.

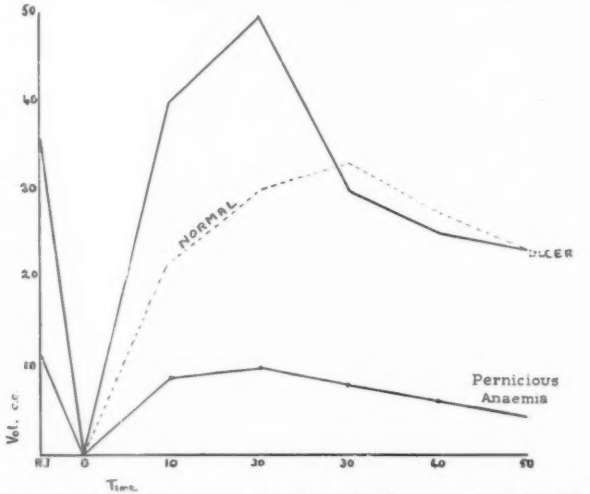


FIG. 3.—Gastric secretion in response to histamine stimulation: average ten-minute volume in 12 cases of duodenal ulcer, 12 normal, and 25 pernicious anæmia.

I would prefer to leave the matter open, but would suggest the following lines of thought in a series of questions:—

(1) Are these differences in the gastric mucous membrane acquired? Does

age and the wearing-out of the mucosa constitute a factor ? (Compare anacidity in relation to age.)

(2) Are they not changes which represent the extremes of two different con-

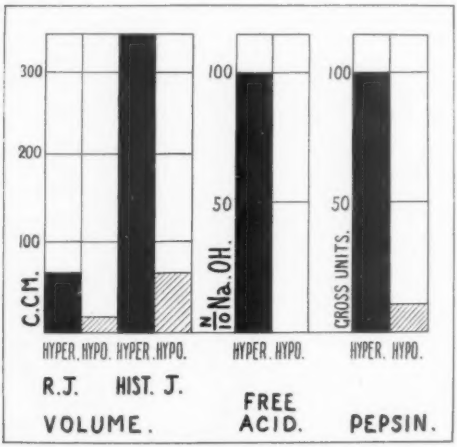


FIG. 4.—Quantitative differences in volume, free acid and pepsin.

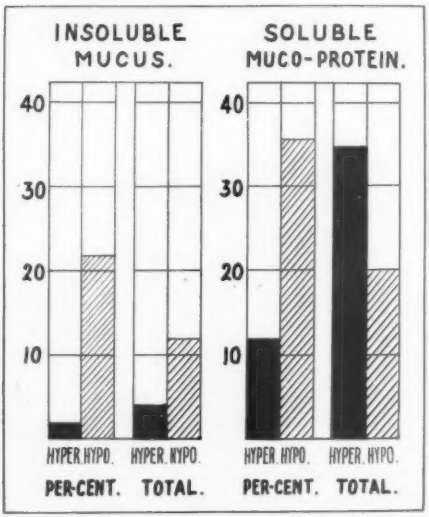


FIG. 5.—Insoluble mucus and soluble muco-protein in the hypersecretory and hyposecretory stomachs.

stitutional types upon which possibly secondary acquired changes have been superimposed ? These types have been long discussed by Hurst :—

(*a*) The hypersecretory type with active, thick, gastric mucous membrane, hyperchlorhydria tending to develop ulcer.

(*b*) The hyposecretory, thin gastric mucous membrane tending to hyposecretion, achlorhydria, and anæmia.

(3) Do the superficial erosions and (?) acute ulcers described in a number of achlorhydric patients cause unsuspected bleeding and become one factor in those cases who develop anæmia ?

(4) What part do acquired infections, exogenous factors (alcohol), or nutritional defects play in producing gastroscopic appearances :—

(*a*) In the hypersecretory ?

(*b*) In the normal ?

(*c*) In the hyposecretory ?

(5) Is it possible that what we have called atrophic gastritis is not a gastritis at all, but a peculiar type of gastric atrophy developing in an individual having the hyposecretory constitution, in response to other (i.e. nutritional or unknown) factors ?

The Practical Application of Gastroscopy

By G. A. M. Lintott, M.D., M.R.C.P.

The survival rate of new methods of clinical investigation is low. The reason lies surely in the fact that so few possess the essential qualities that are necessary to stand the test of time. The most important of such qualities are : Safety, ease of accomplishment, freedom from gross discomfort to the patient, and finally the production of results of value. On the fulfilment then of these demands the success and usefulness of gastroscopy depend.

Of the safety of gastroscopy few need convincing ; its mortality, since the introduction of the flexible instrument, is practically nil, and its morbidity can be measured on a similar scale. Ease of accomplishment is, however, a point on which I should like to say a few words, and I would make a plea for the preservation of such simplicity of technique as is consistent with good results. In the adoption of cumbersome equipment and in the demand for elaborate mechanical aids there lies the danger of gastroscopy being removed from the realms of a simple routine procedure to something little short of an operative measure, to be reserved, after weighty consideration, for special cases in special places. Undoubtedly specially designed and mechanically propelled tables have their advantages, but surely it is better to regard them as a luxury rather than as a necessity. An ordinary table and the simplest of equipment is no bar to good gastroscopic work and, in my opinion, a skilled assistant can be of more value to patient and operator alike than many elaborate contrivances.

And now a few words on the discomfort that this investigation entails. Those who have witnessed the procedure will I think agree that judged objectively gastroscopy appears to be one of the least, if not the least, unpleasant of endoscopic examinations. The patients' own statements confirm this view, which is strengthened by the singular rarity of a second examination being refused should it be required. I have had the opportunity of performing two or more examinations on over 30 patients, the maximum number being 12 in one man, who is still willing for more should the need arise. I have examined several doctors and a medical student, and the evidence of this usually somewhat intolerant and apprehensive section of the community bears witness to the comparatively little discomfort that is produced.

At least four patients have expressed their preference for the short discomfort of gastroscopy to the lengthier hardship of a fractional test meal.

I have particularly stressed these points because we rightly attach so much importance to the patients' feelings. But I think the most sceptical and dubious amongst us can be reassured that gastroscopy, whatever its shortcomings, is a simple and safe procedure which can be employed with a minimum of discomfort and distress.

However, simplicity of technique, ease of accomplishment, and lack of discomfort, are in themselves no recommendation in the absence of results. It is necessary then to examine further the credit balance of gastroscopy. I should like to discuss in particular its value in cases of simple chronic gastric ulcer and also the help that may be derived from its use in the post-operative stomach, rather than deal with the gastroscopic findings *per se* in such cases.

Gastric Ulcer

Let me first consider the value of gastroscopy in cases of chronic gastric ulcer, and this perhaps is best done under the certain headings.

Diagnosis.—In the diagnosis of the majority of chronic ulcers endoscopic examination has little to offer in advance of more established methods of investigation. The efficiency of modern radiological technique renders further examination superfluous in all but exceptional cases. Nevertheless it does happen, from time to time, that an ulcer not seen radiographically is revealed by gastroscopy. These are usually cases in which the history and clinical examination suggest the presence of a gastric ulcer but X-rays show an apparently normal stomach. Here gastroscopy may prove of real help, and the existence of such cases, infrequent though they may be, does at least endow the gastroscope with a certain diagnostic value in gastric ulcer. In a series of 92 gastroscopies performed on ulcer cases I have been able to establish the diagnosis of such a lesion in eight cases in which the skiagrams were entirely negative. Of these, four were sufficiently deep ulcers to warrant the belief that radiography should have revealed their presence.

The converse is equally true, but less frequently occurs : thus in a few patients radiography will reveal an ulcer which cannot be seen with the gastroscope and in the same series two such cases were present. This occasional failure to see an ulcer may be due to a variety of causes. Sometimes the ulcer is prepyloric in site, and therefore lies in what in a normal stomach may be a blind area. This frequently happens when an ulcer is present as a result of an upward retraction of the pyloric antrum. This technical difficulty offers a partial explanation of the infrequency with which simple prepyloric ulceration is seen on endoscopic examination—I have only one such case in my series and in that case, confirmed by operation, the radiograms were, as it happened, negative—but I think that, as Schindler stated, the chief explanation is the comparative rarity of simple ulceration in this region. In this connexion it is important to realize that when carcinoma is present the lesser curvature aspect of the pyloric antrum comes into view much more readily and constantly than in the case of simple ulcer. This is no doubt due to the rigidity or loss of flexibility that is produced in the lesser curvature of the pyloric antrum as the result of malignant infiltration, and thus an area often withdrawn out of gastroscopic vision remains in view. Thus it has been stated that when a prepyloric ulcer is shown by X-rays and not seen by gastroscopy there is slight presumptive evidence in favour of its innocence. Certainly quite large simple ulcers in this region may elude gastroscopic detection but, on the other hand, it must be remembered that neoplastic ulceration by no means invariably comes into view.

Ulcers high up on the posterior wall may not be capable of gastroscopic inspection but these, on the whole, are rare and their detection may be aided by the use of Rodgers' balloon attachment. Another possible but uncommon cause of endoscopic examination failing to reveal an ulcer lies in the fact that thickened folds of mucous membrane may actually overlap and obliterate the site of ulceration. This state of affairs has been described but I have no personal experience of it. And lastly a ring of spasm proximal to the ulcer may hide it from view. Bearing in mind then these few exceptions, the great majority of gastric ulcers can be readily seen with the gastroscope. Their usual site is just proximal to the antral fold, either on the posterior or anterior aspect of the lesser curvature. Their appearance is subject to certain variations which I shall not describe but on the whole it is very typical.

The conclusions we may draw in regard to the diagnosis of an ulcer are these: As a routine measure gastroscopy is not required, but it may prove of real value in a few cases in which an ulcer is strongly suspected and yet radiography fails to reveal its presence. As a diagnostic measure gastroscopy must be regarded as supplemental to radiography and in no way does it supplant the latter as a routine procedure.

Malignant changes in an ulcer.—The gastroscopists will not be allowed to escape the perennial question: Is an ulcer undergoing malignant changes or not? When one realizes how frequently at operation with touch as well as sight at his disposal the surgeon is unable to give a definite answer, the difficulty of forming an opinion based on endoscopic view alone will be appreciated. Is then the gastroscope of no use in these difficult cases when so much may depend upon the decision? My experience is that with due appreciation of its limitations it is always worth while gastroscoping such cases. For by so doing, something may be gained and nothing will be lost. The gastroscopic findings in such cases may be divided into three groups. First, those in which the ulcer is clearly seen and almost unmistakeable signs of malignancy detected, second when the ulcer is again clearly seen and from experience can be said almost certainly to be benign, and third those cases in which the ulcer remains partially or wholly invisible, or when seen, has an appearance on which no definite opinion can be given. The last is, perhaps, the largest group but even here some very cautious conclusions may be drawn. As I have mentioned already, inability to see an ulcer revealed by X-rays in the pyloric antrum may in itself be a hopeful sign. But admitting the lack of definite evidence in the many cases, the positive opinion that can be given in the few does, I think, justify an enlightened use of gastroscopy as an additional means of investigation. For it is here that a decision is so urgently necessary and it is one which may have such far-reaching consequences for the patient, not only in regard to life, but also in deciding the loss or retention of his stomach.

Deformities associated with ulcer.—An hour-glass stomach is nowadays a rarity, but minor deformities of this nature are not quite so uncommon and in these, differentiation of spasm from organic stricture, can usually be made gastroscopically at an early stage. On inflating the stomach with air, constriction due to muscular spasm is as a rule easily overcome; that due to organic changes of course remains. Similar differentiation may sometimes be made between organic and spasmodic obstruction at the pylorus. However, in the majority of these cases, and if the pylorus itself can be viewed, the examination confirms the general opinion that organic obstruction more commonly occurs *beyond* the pylorus; for in these patients it is not unusual to see the pylorus functioning normally.

Assessment of healing.—Finally, I should like to say a few words about what may prove to be the gastroscope's greatest contribution to the management of a case of gastric ulcer. Hitherto the criteria of healing of such an ulcer have been: The

departure of symptoms and signs ; the return to radiological normality ; and finally, the disappearance of occult blood from the stools. The advent of gastroscopy has necessitated revision of such ideas, for all these criteria, not even excepting negative tests for occult blood, may be satisfied in cases in which on endoscopic examination the ulcer appears incompletely healed. Of a small group of seven cases of chronic gastric ulcer, which I subjected to repeated gastroscopy in order to study the relationship between what may be called radiological and gastroscopic healing, all but one showed that healing, as demonstrated by the gastroscope, did not occur until a period of one to several weeks after the disappearance of all X-ray deformity. Examination of many other cases gastroscoped when the X-ray deformity had disappeared confirmed, what of course is well recognized by gastroscopists but perhaps not so generally appreciated by others, that an extensive breach of surface may still be present with all but endoscopic findings indicative of complete healing. This finding, almost universal in the healing of chronic ulcers is, after all, what one would expect, for it is only reasonable to imagine a final stage of superficial ulceration not demonstrable by X-rays. But with the wider appreciation of the existence of this stage in the life of an ulcer and the realization of its sometimes lengthy duration it now seems probable that, in the past, some of the so-called recurrences were relapses occurring in incompletely healed ulcers. It appears therefore not unreasonable to demand the addition of gastroscopic evidence of healing to our other criteria, and thus to allow the duration of strict treatment to be governed by this new and more accurate standard. Nor does this entail great inconvenience to the patient, for only two, or at the most three, endoscopic examinations are required, one while the radiogram still shows deformity so that the ulcer can be clearly seen and its site orientated for future purposes, and a further examination made one or two weeks after the disappearance of the X-ray deformity. Incomplete epithelialization at this stage demands continuation of strict treatment with possibly a further examination later, whereas visual evidence of complete healing will permit a confident promotion to a later stage of treatment. Time will show if the satisfaction of this additional criterion of healing diminishes the tendency to recurrence. If this should be so the addition of the temporary discomfort of gastroscopy to an already tedious régime will bring its own reward. In the meantime, as gastroscopy is the only means of detecting complete healing of a gastric ulcer, it should be used as a routine in this connexion.

If gastroscopy results in longer treatment for the majority of cases, it provides a welcome abbreviation in others. Occasionally an ulcer after prolonged treatment appears to be healed clinically, but a small niche persists radiologically and shows no immediate tendency to diminish in size or to disappear ; in a few of these cases an actual ulcer persists which for some unaccountable reason shows great delay in healing, but this is not the usual explanation. Gastroscopic examination of these apparently intractable ulcers often reveals the cause of the radiological niche as being a depressed scar completely epithelialized. Although its existence has been suspected clinically and radiologically for some time this condition is, perhaps still insufficiently recognized, for its differentiation from an incompletely healed ulcer can only be made by endoscopic examination. The recognition of such a depressed scar is moreover of great value, for then, a welcome alteration in treatment may be allowed. Eventually, I believe, these depressed scars become flattened, and a normal radiological contour returns, but this may take some time.

There are many other features in connexion with the gastroscopic examination of a chronic gastric ulcer. To sum up one may say that the gastroscope may be of help in the diagnosis of certain ulcers, its use being supplemental to that of radiography ; it may provide a valuable link in the chain of evidence collected for the confirmation or exclusion of a diagnosis of ulcer-cancer ; it may occasionally be helpful in the

differentiation between organic and spasmodic contraction secondary to ulceration; and finally, it is *always* of value in the assessment and determination of healing of a gastric ulcer, of which it is our most delicate indicator, and as such a strong claim can be made for its routine use in this connexion.

Post-operative Stomach

The disturbance of the normal anatomy as a result of operation and the not infrequent development of perigastric adhesions make these cases the most difficult with which the gastroscopist has to contend. The usual means of orientation are often lacking, as familiar landmarks may be absent, disguised or situated in unusual places. Nevertheless, with patience and practice the gastroscope can be made to yield much useful information. Gastro-jejunostomy patients still form the largest group of post-operative cases in which the help of gastroscopy is likely to be sought.

Gastro-jejunostomy.—The inconsistency of symptomatology and the difficulty of radiological interpretation of lesions at a gastro-jejunal stoma provide an opportunity for any new means of investigation. To a large extent, I think, gastroscopy satisfies this want, but it must be remembered that technical difficulties, more marked in some cases than in others, tend to modify the advantages that at first sight seem so real. It has been stated by some gastroscopists that with the use of the flexible instrument part or the whole of the stoma can be seen in practically every case. My own experience has not been quite so fortunate. Nevertheless part, if not all, of the stoma can with practice be seen in a great majority of instances, and on looking through my notes of a series of 33 consecutive gastroscopies performed on patients with a gastro-jejunostomy, I find that a complete or almost complete view of the anastomosis was seen in 19, a large part in 8, a small portion only in 2, and in 4 patients the stoma was not seen at all. I know of no means of forecasting the prospects of obtaining a good view but the high proportion of cases in which at least some portion of the stoma is seen, justifies the use of the gastroscope as a routine measure where investigation is required. Moreover, a partial view can prove of real value, for lesions at the anastomosis are seldom strictly localized. Where inflammatory changes are present at a stoma the mucosa of the whole margin is affected in varying degree: thus a portion of the stoma that is seen and appears normal is suggestive of a healthy state of the remainder. The formation of a chronic ulcer is much less frequent than the development of gastro-jejunitis alone, in which of course superficial erosions and submucous hæmorrhages are not infrequently seen. However, it must be remembered that even with the most perfect view it is the gastric surface of the anastomosis that one is inspecting, the jejunal aspect remains hidden. Lesions on this latter side cannot therefore be excluded but their presence may at times be suspected by changes seen on the gastric surface. Conversely, a perfectly healthy gastric aspect is suggestive of similar conditions obtaining on the jejunal surface.

The actual amount of jejunal mucosa seen will depend upon the size of the stoma, the degree of illumination, and the presence or absence of much regurgitation of fluid from the intestine, and this is often considerable. The jejunal can readily be recognized from the gastric mucous membrane by its rather darker colour, and particularly by the appearance and regular disposition of the valvulæ conniventes. Inflammatory changes and at times actual ulceration may be observed in the jejunum.

It has been said that a greater or less degree of inflammation of the stoma is present in all cases in which gastro-jejunostomy has been performed. Gastroscopic findings do not confirm this somewhat pessimistic view, for a perfectly healthy-looking stoma is not infrequently seen and in this connexion it is interesting to note

the sphincter-like action that may be present, and which at times appears almost, pyloric though more rapid, in its action.

When inflammation of the stoma is present it is the rule to find evidence of generalized gastritis as well, and this may be extremely severe but its presence is not invariable even in the case of marked changes at the anastomosis.

In the control of treatment and assessment of healing of gastro-jejunal lesions gastroscopy plays an equally important part, and indeed has been the means of demonstrating that such lesions are often amenable to medical treatment—a point hitherto in doubt.

Partial gastrectomy.—My opportunities for examining cases after partial gastrectomy have been more limited. It is generally agreed that the stoma in these patients is more readily seen than in gastro-jejunostomy cases. Such, has been my experience. The abnormalities that may be present at the stoma are similar to those I have already described but there is one important additional finding that may be encountered. Local recurrence after partial gastrectomy for growth may be diagnosed at an early stage by endoscopic appearance. I had one such case in which gastroscopy, performed eleven months after an apparently successful partial resection of the stomach for carcinoma, showed small nodules of growth in the neighbourhood of the margin of the stoma and thus provided the first evidence of recurrence.

Mr. A. S. Till: It is important when reviewing a series of gastroscopies, to distinguish between those which are done for purposes of research into gastric disorders and those which are of real clinical value and which supply evidence not obtainable by other means of investigation.

There are four common indications for gastroscopy in the latter group :—

(1) Patients with gastric symptoms and negative investigations in whom some form of gastritis may be found.

(2) Those cases in which the skiagram is suspicious of carcinoma.

(3) To follow the healing of a peptic ulcer.

(4) To diagnose anastomotic ulcer.

In this last group the examination is often difficult to carry out and the results are disappointing. Mr. Lintott had called attention to some of the difficulties of gastroscopy. The examination was in no way so easy as for example cystoscopy, but he had obtained useful results although he had not had the great experience in gastroscopy of the opening speakers. Of the first 175 cases gastroscoped and followed up at the Middlesex Hospital, 30 were examined on account of barium meals which were inconclusive or suggestive of carcinoma. Ten of these cases were shown to have growths and 41 gastric ulcers. In six, however, the gastroscopic report had been incorrect, as shown by the subsequent history of the patient.

Dr. P. E. T. Hancock: Gastroscopy is usually performed under local anæsthesia although it may also be performed under a general anæsthetic or under evipan or a similar hypnotic. Nearly all gastroscopies are, however, performed under local anæsthesia, and in this country most gastroscopists use a 2% solution of decicain with or without the addition of adrenalin. Most of us have been impressed by

the efficacy and the lack of toxic symptoms associated with the use of decicain. There are, however, certain dangers consequent upon its use and they should be mentioned. The manufacturers themselves strongly advocate the addition of 1 to 2 minims of adrenalin per c.c. of decicain and they state that not more than 2 to 3 c.c. of the 2% solution should be used, that is an equivalent to approximately 0·06 grm. of decicain. Their reasons for suggesting the addition of adrenalin appear to be purely theoretical as they are unable to quote any experimental work proving that the absorption or toxicity of decicain is lessened by its use. In recommending the dosage, they are naturally playing for safety, as this dose would be below the theoretically fatal dose of decicain given intravenously if man be comparable with rabbits and dogs on whom the toxicity work was done. Furthermore, most gastroscopists have been in the habit of using larger doses than the 2 c.c. recommended by the manufacturers without experiencing toxic results.

Professor Schindler now working in Chicago has carried out over 2,000 instrumentations using 10 c.c. of a 2% solution, and has never had any toxic manifestations. Professor Henning working in Germany, in a personal communication, tells me that he has had no toxic manifestations using 2·5 c.c. of 2% solution in a large series of instrumentations. I have, however, come across two accounts of fatalities following the use of decicain in preparation for gastroscopy, one in Minneapolis, which case is recorded in " The Staff Meetings Bulletin of the University of Minneapolis Hospitals ", Vol. 9, No. 2. This was a man aged 57 who had 5 c.c. of 2% solution with the addition of 5 minims of adrenalin and he died soon after the injection with typical cocaine convulsions. At autopsy he was found to be suffering from syphilis of the aorta and central nervous system and carcinoma of the stomach with metastases in lymph-nodes and right spermatic cord. The same observer had two other cases of minor convulsions which, at the time, were thought to be hysterical. The other case occurred in this country and resulted in the death of a man aged 72. His preparation included a decicain pastille 1 gr., and approximately 7 c.c. of 2% solution. He developed typical cocaine convulsions before the stomach tube and gastroscope had been inserted. At autopsy he was found to have a carcinoma of the stomach. In this case no adrenalin was used. About three months previously this man had been successfully gastroscoped after having a 1-gr. decicain pastille and 5 c.c. of 2% decicain solution. This same observer had one other experience of convulsions following a similar form of preparation and considered them to be hysterical; they recurred during the injection of evipan at a slightly later date.

A certain number of toxic results including fatalities have been recorded using decicain in 2% solution for tracheal and bronchial anæsthesia, where apparently the vaporization is dangerous, and also in several urethral conditions in which there has been damage of the superficial epithelium and probably absorption into a venous sinus.

I myself have carried out just over 450 instrumentations using from 2 to 10 c.c. of 2% decicain solution without the addition of adrenalin without any ill-effects. Mr. Harold Rodgers has carried out over 700 instrumentations using a similar technique also without ill-effects.

I have, however, developed what I believe to be an improvement in technique at the same time adding a safety factor. I have pastilles made for me which contain 1 gr. of decicain in a plain gelatine base. This pastille is sucked by the patient twenty minutes before instrumentation. As a result of this the patient usually has almost complete anæsthesia of the mouth and throat at the time of instrumentation and frequently no further anæsthesia is required. If the pharynx is not quite anæsthetic I use 3 c.c. of decicain solution and the discomfort of

introducing this is considerably lessened by the previous pastille. I have discovered no disadvantages such as the appearance of increased gastric secretion or swallowed mucus in the stomach, and it has the big advantage of saving time in those patients not requiring further anæsthesia, and saving them what is sometimes the most unpleasant part of the examination, the rather violent retching which may result from the first introduction of the cannula to the back of the throat. I believe it also adds a safety factor, as the patients who develop symptoms from decicain are probably hypersensitive to it, in which case one would expect them to develop those symptoms during the time they are sucking the pastille, when they would only have received a very small dose, and the rest of the pastille would be rejected. I have myself been using this pastille for eighteen months and have used it on 235 occasions without any ill-effects and it has, I believe, made the examination easier and less unpleasant.

In conclusion I would like to say that in my opinion decicain is safe when used in the preparation for gastroscopy, but probably not more than 5 c.c. of the 2% solution should be used, alternatively a 1-gr. decicain pastille and 3 c.c. solution. As to whether adrenalin lessens the likelihood of toxic manifestations in this particular use of decicain, is still doubtful.

Mr. Howell Hughes gave an analysis of the first 500 patients gastroscoped at the Liverpool Royal Infirmary, as shown in the following table :—

	%
Normal	7·5
Normal mucosa with pylorospasm	3·5
Subacute ulcers or erosions	2·5
Chronic gastric ulcers	28·5
Chronic hypertrophic gastritis including gastro-jejunitis	25·5
Chronic hypertrophic gastritis with pylorospasm	25
Neoplasms (including one simple)	7·5

In certain patients he had noted that the subacute gastric erosions were accompanied by small superficial buccal ulcers, very similar in character to those in the stomach. He had found that the association of pylorospasm with hypertrophic gastritis pointed to active ulceration of the duodenum. In spite of the modern high standard of clinical investigation, especially of radiological technique, there are undoubtedly cases where the diagnosis remains uncertain ; here gastroscopy may reveal the true nature of the lesion. He showed a series of pictures to illustrate actual cases where gastroscopy was able to resolve such a doubt.

Dr. Robert Coope (Liverpool) approached the subject as a general physician who was grateful for the help of the gastroscopist in many of his cases. To the contra-indications of gastroscopy he would add the existence of certain types of aneurysm of the aorta, where the œsophagus was seen after a " barium swallow " to be pushed out of its normal course. Gastroscopy might be invaluable in differentiating simple ulcer from carcinoma, especially in those patients of the " cancer age " with an unusual history—patients with a short history of indigestion, where X-ray examination or test meal might suggest confirmation of the diagnosis of carcinoma, yet who were in fact suffering from ulcer ; and patients with a long history of indigestion, and therefore who were more likely to have a chronic ulcer, who nevertheless were shown to have carcinoma. Moreover, even laparotomy by the most competent of surgeons occasionally was inconclusive ; he had had recently under his care a patient in whom a first operation had failed to reveal a good-sized ulcer of the lesser curvature, but after

gastroscopy had shown the ulcer, a partial gastrectomy was then performed, to the great relief of the patient's sufferings.

Gastroscopy had shown him how often the pain and other symptoms might disappear with subsidence of the œdema round the ulcer and of the congestion of the gastric mucous membrane, yet the ulcer was still far from healed: a thoroughly salutary experience which emphasized the need for time and care in treatment.

He referred also to the value of actually seeing an ulcer in situ. A patient in whom gastroscopy revealed an ulcer at the pylorus later had hæmatemesis; it was clear from the previous gastroscopy that it was unlikely that the bleeding would stop of its own accord, and within a few hours there was renewed vomiting of fresh blood. Fortified by the knowledge gained from an actual view of the ulcer, it was justifiable to ask a surgical colleague to deal directly with the bleeding point, and this was done successfully.

Dr. Denys Jennings: The angulus of the stomach is a functional and not an anatomical landmark. It may be higher up the lesser curve and further from the pylorus when the patient is lying on his left side for gastroscopical examination than when he is standing erect with a heavy barium meal in his stomach. The consequence of this is that the apparently admirable view of antrum and pylorus which is usually obtained with the flexible instrument may be deceptive, the true pylorus being either round the corner or concealed by a prepyloric contraction. It is thus possible to think that one has obtained an excellent view up to the pylorus, and actually to miss a prepyloric lesion. This danger is less likely to occur with the rigid instrument which does not fall away towards the left iliac fossa to the same extent. If the rigid instrument does not impact against the posterior wall and if it descends sufficiently far into the stomach, the angulus tends to form at the junction of the thick-walled antrum and thinner-walled body, and a much closer view of the pylorus is usually obtained.

Too little attention is being given to the fact that in the majority of cases the flexible instrument is incapable of distinguishing fine details in the prepyloric region where, as pathologists are agreed, inflammatory changes principally occur. With the classical Schindler rigid instrument lying side by side with a modern flexible 85° one, the image seen through the rigid will be twice the size of that seen through the flexible. The flexible gastroscope inevitably falls away from the pylorus more than the rigid one and with the optical arrangement employed, the size of the image rapidly decreases as the distance increases. The image of the pylorus seen through the flexible instrument may thus be only a quarter the size of that given by older types.

In order to get over this disadvantage, the Cambridge Instrument Co. have made me a powerful electromagnet and a soft iron tip to a flexible instrument. Unfortunately, the apparatus is better in theory than in practice, and though it gives me excellent controlled vision in the body of the stomach, I am disappointed with the amount of improvement in the antral view which I can rely on getting in the absence of X-ray control. Professor Schindler very kindly wrote to me recommending his latest type of 50° gastroscope (which of course gives a larger image). This may be the ultimate solution, to combine controlled movement with a narrow angle objective giving higher magnification and less distortion.

Previous speakers have seemed a little at a loss as to what is normal and what is abnormal in the gastric mucosa, and have hinted at the existence of different constitutional types. My own view, based on the examination of a few healthy subjects from the Tyrol, is that a perfectly healthy mucosa can occur in adults, comparable

gastroscopically with that seen in a cat, pig, or dog, but that such a mucosa is as non-existent in the adults of a civilized community as is a well-developed mouth with perfect teeth in an English town. A primary atrophy as a cause of achlorhydria may exist as an uncommon constitutional anomaly but with this possible exception, the sameness of the few healthy stomachs which I have seen in adults from the Tyrol and in youths under 20 makes me disinclined to believe in the existence of different types. The variety of appearances found in the body of the stomach, regardless of whether the patient has indigestion or not, are in my opinion chiefly due to variations in tone and in the amount of scar tissue in the underlying muscularis mucosæ and not to any congenital variation in thickness.

Section of Urology

President—H. P. WINSBURY-WHITE, F.R.C.S.

[*November* 24, 1938]

Carcinoma of Kidney.—F. MACG. LOUGHNANE, F.R.C.S.

Patient, male, aged 46.

History.—One attack of hæmaturia. Cystoscopic examination made the same day. Bladder full of clot, which failed to be washed out after forty minutes' lavage; patient returned to the ward and instructions given for glycerine-pepsin to be used and daily bladder wash-out given. A descending pyelogram showed a hydronephrosis on the left side, but the right was not visualized. A week later the bladder was still obscured by clot, so the lavage was continued for another week. Cystoscopy then showed a normal bladder. A right ascending pyelogram revealed dilatation of the upper calyx with narrowing of the stem, and also that there was a greater space between the middle and upper calyx than between the middle and lower. The urine was sterile, and the kidney was not palpable, but a diagnosis of renal neoplasm was made. At operation a large tumour was found fixed high up under the ribs. It was mobilized and brought to the surface. The growth was found to extend along the renal pedicle and into the vena cava, and was removed close to the vena cava.

Pathological report: Completely necrotic solid trabecular polygonal-celled carcinoma of the kidney.

Solitary Suppurating Cyst of Kidney with Retrograde and Intravenous Pyelograms.—J. LLEWELLYN DAVIES, F.R.C.S.

F. P., a woman aged 36, referred to me at the Nottingham General Hospital with a history of onset six weeks ago of cystitis and right pyelitis, accompanied by a high temperature which had lasted for four weeks.

On examination.—Patient looked ill and had an enlarged and tender right kidney. Laboratory report on urine: No abnormality; no growth on culture. Cystoscopy revealed a normal bladder. After intravenous indigo-carmine there was normal excretion from the left kidney but delayed from the right. Retrograde and intravenous pyelograms show on the right side a flattening of the upper pelvis and calyces.

Operation.—Right nephrectomy. The upper third of the kidney was found to be replaced by a solitary cyst measuring about 4 by 3 in. This was firmly adherent to the diaphragm, peritoneum, and inferior vena cava. It contained thin yellow pus under great tension. The patient made a good recovery.

The pyelogram (*see* above) is shown as a good illustration of pressure effects by a cyst as distinct from infiltration by a neoplasm.

Congenital Right Hydro-ureter.—REGINALD T. PAYNE, M.S.

History.—The patient was a male, aged 47, who had worked for many years in the East as an accountant. During childhood he suffered from nocturnal incontinence until the age of 6, and possibly later. There was no trouble whilst he was at boarding-school or whilst in the Army during the Great War. The patient, however, said that he had always regarded himself as having a rather weak bladder and always had to pass urine rather oftener than most men. During the previous six years there had been a steadily increasing frequency and urgency, but there had been no pain or abnormality in the urine, and the stream had been good. All these symptoms had become much worse during the six weeks since the patient returned to this country on leave. At the time of examination in June 1938, there was a frequency of about ten times a day and usually once at night. As soon as there was a desire to micturate the patient had to answer it at once, otherwise incontinence occurred immediately. Any form of fluid, or at times even the thought of a drink, might initiate the train of symptoms. Incontinence as a symptom started some two years ago, and since then had occurred approximately three or four times every day. The patient's difficulties had caused him extreme distress and led to serious limitation of his professional and social activities.

Past history.—At the age of 7 the patient had had rheumatic fever and pneumonia, but since then he had been healthy.

Physical signs.—The patient was in good general condition. The urine was normal. Examination of the urinary tract after uroselectan showed no abnormality on the left side. On the right side the kidney was small and the calyces were moderately dilated, but the organ secreted well in skiagrams taken at twenty minutes.

In the same film and even more so in the film taken at thirty-five minutes, an extreme degree of dilatation of the pelvic portion of the ureter was seen. Instrumental pyelography was subsequently carried out. It was impossible to get the ureteric catheter to pass up the ureter, as the tip repeatedly impinged in the wall. Pyelography had to be carried out with a cystoscope in situ. Fig. 1 shows the enormous degree of dilatation of the ureter which was present. The bladder wall and the ureteric orifices were normal. Blood-urea 37 mgm.%.

Operation.—Uretero-nephrectomy was carried out on the right side, the kidney and ureter being removed in one piece and the ureter divided at the bladder base. The first part of the operation was carried out through a mid-line sub-umbilical incision, and the second part through a right lumbar incision. In its pelvic course the ureter was very tortuous as it passed from the pelvic brim to the bladder. It mobilized easily and after ligation was easily pushed up into the retroperitoneal tissues of the

FIG. 1.

FIG. 2.

posterior abdominal wall. Owing to the small size of the kidney, and the large size of the ureter, it was impossible to mobilize the kidney on to the surface of the body, and the nephrectomy had to be carried out without delivering the organ.

Pathology.—The kidney itself was 8·5 cm. long, but had preserved its general shape (fig. 2). The surface of the organ showed some irregularity, with a tendency to lobulation. Some of the depressed areas were scars, others were in relation to the dilated calyces, and in these latter situations the renal tissue was extremely thin. There was a moderate degree of dilatation of the pelvis and calyces, but a considerable amount of renal tissue remained. The ureter itself left the pelvis as a grossly dilated structure, 3·5 cm. wide. The rest of the course of the ureter showed a similar degree of dilatation with two regions of slight narrowing, one in its abdominal course and another in its pelvic course. Although the ureter was grossly dilated, the thickness of the walls was approximately that of the normal ureter.

Histologically, the kidney showed a considerable amount of normal secreting tissue. Sections of the ureter (van Gieson's stain) showed a marked degree of fibrosis of the wall with breaking up of the muscular coats.

The specimen is now in the Museum of the British Postgraduate Medical School, Hammersmith.

Subsequent history.—The patient made a very good recovery from operation.

Discussion.—This case is reported on account of the unusual symptoms of precipitancy of micturition and incontinence. In reviewing the patient's history it is practically certain that there had always been some urinary symptoms, which had progressed with age. In view of the normality of the ureteric orifices on cystoscopic examination and the complete relief from symptoms which followed operation, I think their explanation must be that the right ureter, instead of allowing urine to pass into the bladder in small amounts, allowed a large quantity—probably several ounces—to enter at once and thus cause the intense desire to micturate with precipitancy and incontinence.

Adenoma of Kidney with Multiple Serous Cysts at Lower Pole.—GEOFFREY PARKER, F.R.C.S.

L. C., male, aged 72.

Admitted to hospital with a history of pain in the left abdomen and progressive enlargement of the left kidney. Uroselectan showed tumour at the lower end of the kidney displacing and compressing the pelvis upwards. Blood-urea 56 mgm.%. No history of hæmaturia.

31.5.38 : Operation. Left nephrectomy.

24.6.38 : Discharged cured.

Specimen shows a small adenoma arising apparently from the kidney substance at the lower angle of the renal pelvis, and gross cystic degeneration of the whole lower pole of the kidney.

Advanced Urinary Tuberculosis treated by Presacral Neurectomy.—GEOFFREY PARKER, F.R.C.S.

F. G., male, aged 23 ; student.

Past history.—Pulmonary tuberculosis. 1934 : Right tuberculous pyonephrosis ; nephro-ureterectomy carried out in France.

November 1936 : Admitted to the French Hospital, London, complaining of progressive loss of weight, hæmaturia, pyuria, and severe dysuria and frequency every quarter to half an hour and ten to twelve times nightly. The patient's condition was pitiable and he was rapidly going downhill.

Cystoscopy : The bladder capacity under spinal anæsthesia was less than 4 oz. ; gross œdema and tuberculous ulceration round the left ureter and trigone. Urine contained pus cells, blood, and tubercle bacilli.

17.11.36 : Operation. Presacral neurectomy through a mid-line incision.

Progress.—Frequency was considerably reduced within a week after operation. After leaving the hospital the patient returned to Switzerland and appeared again at the French Hospital in November 1938 (two years after operation) complaining of intermittent anuria associated with left renal pain. He has no bladder pain ; passes water three or four times during the day without pain, and is not disturbed at night.

X-rays show dilatation of the ureter down to the bladder, and this appears to be due to fibrosis in the intramural portion of the ureter. Urine contains pus cells and tubercle bacilli.

Cystoscopy : Bladder capacity 11 oz. Tuberculous ulceration round left ureteric orifice and tuberculous granulation tissue protruding from the ureter. Left ureter dilated with bougies.

Progress.—Night temperature 99° F. Blood-urea 29 mgm.%. One mild attack of left renal pain since operation, otherwise well.

Circumrenal Hæmatoma.—JAMES CARVER, F.R.C.S.

The causes of circumrenal hæmatomata are many. They include disease of the kidney, such as hydronephrosis and calculus; disease of the neighbouring blood-vessels, such as aneurysm, atheroma, thrombosis, and peri-arteritis nodosa; injury and blood disorders, such as hæmophilia. In three cases reported by Heritage from the records of the London Hospital, the patients were admitted as abdominal emergencies. In one of these cases there was a growth of the suprarenal gland. One of my specimens is probably due to hydronephrosis and the other to hæmorrhage into the suprarenal gland due to hypertension.

I.—D. R., male, aged 43, a window-cleaner.

History.—Admitted to Fulham Hospital on 24.2.37 complaining of pain in the right hypochondrium and right loin from which he had suffered intermittently for over six years. The pain, which was accompanied by vomiting, had been constant during the week before his admission. There was no history of injury and there never had been hæmaturia or urinary symptoms.

On examination.—There was a large tense tumour occupying the right flank and the iliac fossa and extending beyond the middle line. It was thought to be a hydronephrosis.

Investigations.—Urine: A few traces of albumin. Few R.B.C. Sterile on culture. Blood: Wassermann and Kahn reactions negative. Blood-count: R.B.C. 4,620,000; Hb. 78%; C.I. 0·85; W.B.C. 14,400 (polys 84%; lymphos. 12%; hyals. 1%; eosinos. 2%).

X-rays showed no evidence of calculi.

Uroselectan: Normal kidney on left side. No signs of dye after forty-five minutes on right side.

Cystoscopy: Normal bladder. Ureteric catheter could not be passed beyond the right sacro-iliac joint and an attempt at a pyelogram was not successful. It was possible, however, to see the outline of the ureter which was displaced beyond the lateral border of the vertebræ on the left side. Some of the dye had reached the kidney, showing a hydronephrosis at the lower pole.

Operation.—The tumour mass was removed by the usual loin incision. Operation was difficult, there being many adhesions.

Specimen.—The specimen (fig. 1) weighed 32 oz., and examination revealed a marked degree of hydronephrosis of the upper third with dilatation of the calyces of the remaining portion of the kidney. The kidney substance is thin and the pattern is completely lost. The capsule of the kidney is intact and outside it is a large hæmatoma conforming to the kidney outline. This hæmatoma has an adventitious capsule and beneath it in several places is a layer of fat. Microscopic examination of the hæmatoma shows it is undergoing organization.

II.—S. W., aged 47, a messenger, admitted to St. Mary Abbots Hospital on 2.7.38.

History.—For twelve months there was nocturnal frequency and occasional pain in the left loin. For six months loss of weight, anorexia and dyspnœa, and occasional attacks of epistaxis. A week before admission there was hæmaturia which lasted for two days. Recently the patient had been suffering from severe headaches.

On examination.—The patient looked very worried and was obviously ill. The heart was enlarged with a systolic murmur at the base and apex. Blood-pressure 285/165. Tenderness in the left loin.

Investigations.—Urine: Sp. gr. 1006. Albumin and traces of blood. Wassermann and Kahn reactions negative. Blood-urea: 135 mgm.%. Uroselectan: There was no evidence of dye seen in either kidney after forty-five minutes.

Eyes: Discs grossly œdematous with blood in their edges. Physiological cup filled in. Arteries: Irregular calibre, narrow lumen. Hæmorrhages present. Macula: A few hæmorrhages and œdema.

FIG. 1.

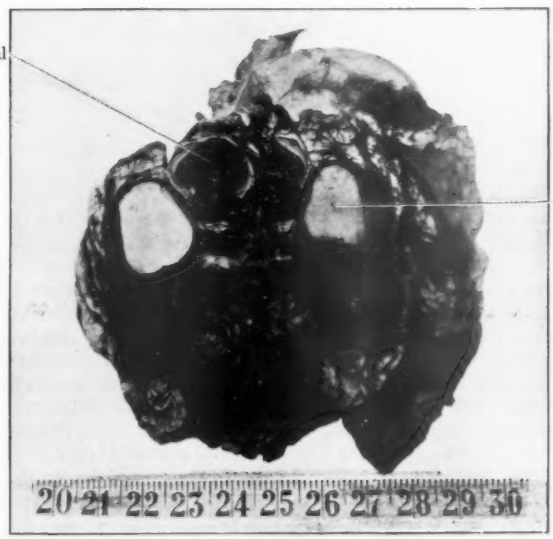


FIG. 2.

Progress.—The patient's mental condition became gradually worse and he died rather suddenly on July 21, three weeks after admission. For a few hours before he died he complained of severe pain in the left loin and flank, and was tender and rigid on examination.

Post-mortem report (Dr. W. G. Barnard): Hæmorrhage into left adrenal gland; slight cortical hyperplasia of opposite adrenal; "heart-failure" liver; slight œdema of spleen; ischæmic fibrosis of kidney; atheroma of aorta; slight inflammatory infiltration round vasa vasorum in outer media; slight myo-adenomatosis of prostate, with cystic dilatation of tubules.

The specimen is illustrated in fig. 2. The upper pole of the kidney has been divided and the almost completely destroyed suprarenal gland is seen. The hæmorrhagic mass occupied the whole of the perirenal fossa.

Bilateral Renal Decapsulation for Nephritic Anuria.—Terence Millin, M.Ch.

R. H., male, aged 11. Transferred from Cottage Hospital by ambulance on April 28, 1938, on account of anuric coma of five days' duration following an acute nephritis; cause unknown. The patient was markedly œdematous; the scrotum was the size of a Rugby football, other parts being similarly swollen. No urine had been passed for five days. Intravenous therapy had been tried without avail. Soft rubber catheter withdrew 3 c.c. only from the bladder.

Investigations.—Blood-urea 192 mgm.%. Blood-pressure 130/100. Urine analysis: Granular casts +++; 120 R.B.C. to the field; almost solidified on boiling. Blood examination: R.B.C. 3,170,000; Hb. 75%; W.B.C. 16,400. Sedimentation rate, 42 mgm. per hour. Operation (same day). Bilateral renal decapsulation. Practically no anæsthetic was required, a little gas-oxygen being administered. Both kidneys were enlarged and œdematous. Each kidney decapsulated in turn through usual oblique subcostal incision. Total operation time eighteen minutes. Patient returned to bed in good condition, 65 oz. of urine secreted in the next twenty-four hours.

30.4.38: Blood-urea 164 mgm.%. Urine analysis: A few hyaline and granular casts. 30 R.B.C. to the field. 6.5.38: Blood-urea 48 mgm.%. Albumin 1% (Esbach). 8.5.38: Albumin 0·6%. 9.5.38: Blood-urea 40 mgm.%. 28.5.38: A very faint trace of albumin. Very occasional hyaline cast. Patient allowed up. 5.6.38: Patient discharged.

The case is recorded as an example of the value of the operation of renal decapsulation in anuric cases which fail to respond to intravenous therapy. This boy's urine is now completely negative. There is no albumin, and microscopy shows no evidence of casts.

Extensive Calculous Disease of the Prostate treated by Transurethral Methods Nine Years Ago.—Terence Millin, M.Ch.

C. H., male, aged 54. Urinary frequency for many years; prostatectomy advised and refused in 1913 and again in 1919. Admitted with overflow incontinence October 1929. Skiagram (fig. 1) revealed very large calculous prostate. Treatment: Preliminary catheter drainage, followed by electro-coagulation under spinal anæsthetic and multiple incisions with cystoscopic knife (devised by the late Mr. Canny Ryall, similar to that now known as the Collings' knife), liberating number of calculi. Between forty and fifty were subsequently passed. Second skiagram (fig. 2), taken two years later, at which time the patient was symptom-free, shows almost complete

FIG. 1.

FIG. 2.

disappearance of calculi. This patient was seen recently (nine years after operation), and is in perfect health.

This case illustrates the manner in which calculous prostatitis may be treated successfully by transurethral methods. It is well known that suprapubic extirpation is frequently difficult, and does not invariably give a satisfactory end-result.

Pyo-ureter of a Double Kidney.—LESLIE N. PYRAH, F.R.C.S.

M. P., female, aged 8. Had three or four attacks of pain in the left side of the abdomen during the eight months preceding examination. The pain has been fairly severe; it was usually located in the left iliac fossa and did not radiate to the back. It was associated with elevation of temperature to 101° F. and pulse-rate to 120 and with all the symptoms of a febrile illness. No disturbance of micturition. The last attack was accompanied by rigor.

On examination (28.8.38).—Temperature 101° F. Pulse-rate 120. Child obviously ill. Abdomen: Soft elongated tender swelling low down in the left iliac fossa, and actual definition difficult on account of the associated rigidity.

Subsequent course.—The child was given fluid diet; fomentations were applied to the left side of the abdomen. The temperature fell gradually and the swelling diminished in size and in tenderness. After a few days it was possible to feel an elongated cystic fixed swelling in the left iliac fossa. Its upper and lower borders could not be defined. There was no spinal rigidity.

Investigations.—Urine: Contained pus cells in small numbers and gave a growth of *B. coli*. Skiagram of urinary tract: No evidence of calculus. Intravenous pyelograms (Abrodil): Right kidney showed good secretion and normal outline of pelvis and calyces. Left kidney showed moderate dilatation of pelvis and calyces.

Cystoscopy: Bladder capacity normal. Only one ureteric orifice was seen on each side and both appeared to be normal. Both kidneys were secreting indigo-carmine normally.

On examination of the abdomen under anæsthetic it was possible to feel the lower pole of the left kidney above the cystic swelling. The latter appeared to be retro-peritoneal.

In view of the persistence of the swelling, which did not vary much in size during the next few days, an exploratory operation was undertaken. An oblique incision was made in the left iliac fossa and the cystic swelling was found to be a very large, tortuous pyo-ureter. The ureter was traced upwards, and was found to be connected with an accessory pelvis occupying the upper third of the left kidney. A normal ureter was found deep to the accessory pyo-ureter and internal to it. Both ureters

joined near the bladder. The lower two-thirds of the kidney were soft and felt to be moderately hydro-nephrotic. The question of a partial resection of the upper portion of the kidney was considered but the child's condition was not very good and it was decided to remove the kidney with the two ureters intact.

Patient made a normal recovery.

Squamous-cell Carcinoma of Kidney.—G. C. SAWYER, F.R.C.S.

Patient, female, aged 74.

First symptoms, which occurred in 1933, were those of left renal pain and profuse hæmaturia. Intravenous pyelography showed a large left kidney with hydronephrosis and a poor concentration. No calculus was present. Operation was considered inadvisable owing to patient's age, obesity, and breathlessness. She remained reasonably well until July 1937 when there was a further attack of hæmaturia and from then onwards a large tumour became obvious in the left loin.

On admission into hospital in January 1938 there was a large renal tumour the size of an ostrich's egg, quite hard and rounded but not nodular. Blood-urea was normal. Intravenous pyelography showed non-function on the left side with a normal appearance on the right. Cystoscopy showed a contracted orifice on the left side with no efflux. Excretion of dye was completely absent.

Operation by Mr. Zachary Cope on 28.1.38 revealed an inoperable renal tumour, quite fixed and with much local extension. Biopsy was performed and showed a squamous-celled carcinoma. Several ounces of pus were aspirated from the renal pelvis. The patient died on 27.2.38.

Post-mortem examination showed a large pyonephrotic kidney. At the lower pole was a carcinoma arising from the renal pelvis and infiltrating renal tissue. Almost all the renal substance had been destroyed. Pyonephrosis had apparently developed owing to obstruction by the growth of the uretero-pelvic junction. No calculus was present. The tumour was adherent to the aorta, vena cava, peritoneum, and descending colon. Aortic glands were infiltrated and there were secondary metastases in the lungs.

Squamous-celled carcinomata of the kidney are not uncommon but are usually associated with a chronic infection or a calculus. In this case, no calculus was present. The obstruction was almost certainly due to the tumour arising at the lower pole. It is unlikely that the tumour was secondary to the hydro- or pyo-nephrosis as the initial symptom was profuse hæmaturia. Previous recorded cases give quite a short history ; an average of from ten to eleven months has been quoted, but here it seems that the condition developed slowly over a period of four years.

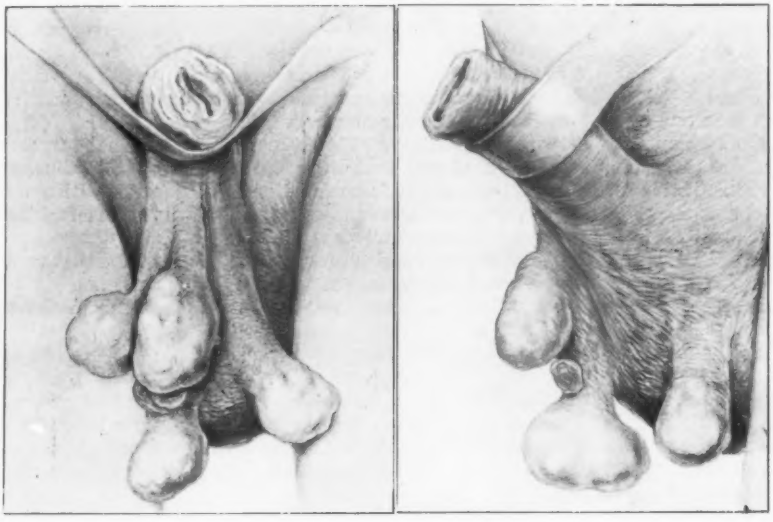
Demonstration of Apparatus for Endovesical Photography.

Dr. ERNST SKLARZ showed a new photographic cystoscope with a powerful optical system which gives a sharp image of a large bladder field. This cystoscope can be used with Gullbring's camera so that black-and-white and colour photographs can be easily taken, and by means of the finder on the camera the interior of the bladder can be observed. Large sharp bladder field, instantaneous exposure and images correct to shape and colour combined with simplicity of procedure are the main advantages of these new photographs, which provide an exact record for practical and teaching purposes.

Dr. Sclarz demonstrated the appliance, black-and-white photographs, reproductions of colour films by printing on colour-sensitive photographic paper, and lantern projection of actual colour films. (See also *Lancet*, 1938 (ii), 728, 1232.)

Sebaceous Adenomata of the Scrotum.—A. Clifford Morson, O.B.E., F.R.C.S.

Sebaceous adenoma of the scrotum is a rare disease. It is a congenital lesion, and the tumours are always multiple. This condition must not be mistaken for the sebaceous cysts which occur so frequently in the skin of the scrotum. It is a pathological curiosity rather than of clinical interest, for the general state of health is never disturbed by the presence of this disease and no complications are likely to occur locally.



History.—The patient, aged 74, was admitted to hospital on account of chronic bronchitis. During routine examination it was noted that there were multiple pedunculated tumours growing from the skin of the scrotum. The patient stated that they had been present all his life, though of recent years they had become more pendulous. It was with difficulty that he was persuaded to have one of the tumours removed under local anæsthesia for the purpose of microscopic examination.